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PUBLIC NOTICES.

Technical Assistant

MECHANICAL ENGINEER (unpensionable) REQUIRED for Royal Small Arms and Gunpowder Factories, Enfield and Waltham Abbey. Degree in Engineering or its equivalent, and not less than 3 years' workshop training in an engineering establishment, preferably with firm manufacturing steam and electrical plant, essential. Knowledge of Hydraulics desirable. Salary £175 to £275 per annum plus Civil Service bonus (present total about £240 to £350). Must be British subject. Age not exceeding 27 years. Preference and age concession to ex-Service men.

Application forms, returnable by 17th December, obtainable from CHIEF SUPERINTENDENT of ORDNANCE FACTORIES, Royal Arsenal, Woolwich, S.E.18. 9237

Government of Madras.

APPLICATIONS are INVITED for the under-mentioned APPOINTMENTS in connection with the Construction of Harbour Works at Cochin, Madras :—

(a) EXECUTIVE ENGINEER.
(b) ASSISTANT ENGINEER (MECHANICAL).

QUALIFICATIONS REQUIRED.—For appointment (a) : Corporate membership of Institution of Civil Engineers. Good general experience in design of important engineering works, practical outdoor experience of construction of railways, bridges and other major structural works at home and abroad. Intimate knowledge of Indian conditions, resources and markets, both as regards material and labour, as well as the contract system of execution of public works, an advantage. Age should preferably not exceed 45 years.

For appointment (b) : A five years' indentured apprenticeship in engineering workshop, preferably in shipbuilding yard, with subsequent practical experience in engine-room aboard ship, including experience on suction dredger. Must be qualified theoretically either by Board of Trade Examination or by training in Engineering College or University. Experience in dredging in the East (including periodical docking and overhaul of dredgers) and expert acquaintance with internal combustion engines an advantage. Age should not exceed 35 years.

TERMS.—For appointment (a) : Three years' agreement with possibility of extension. Pay in accordance with age, qualifications and experience, subject to maximum of Rs. 1500 per calendar month. First-class passage out and home to officer of non-Asiatic domicile. Provident Fund. Travelling allowances.

For appointment (b) : Five years' agreement. Pay Rs. 450 a calendar month, rising annually by Rs. 25 to Rs. 550 a calendar month. Second-class passages out and home for officer and family if of non-Asiatic domicile. Provident Fund. Travelling allowances.

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Forms of application and further particulars may be obtained (upon request by postcard) from the HIGH COMMISSIONER FOR INDIA, General Department, India House, Aldwych, W.C.2. Last date for receipt of applications 23rd December, 1932. 9240

Northampton Polytechnic Institute.

ST. JOHN-STREET, LONDON, E.C.1.

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Particulars of the appointment and application form will be forwarded on request.

Salary scale, £730-25-930, less 10 per cent. "economy" reduction.

It is possible that an initial salary in excess of the minimum may be authorised should this appear warranted by the successful candidate's previous experience in a department of equivalent standard.

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The candidate appointed will be required to enter upon his duties on June 1st, 1933.

S. C. LAWS, M.A., M.Sc.,
Principal.
9252

Metropolitan Water Board.

TURBINE CONNECTIONS, KEMPTON PARK PUMPING STATION.

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The drawings and contract documents may be inspected without charge at the offices of the Board, Chief Engineer's Department (Room 201) on and after Monday, 12th December, 1932.

Forms of Tender, conditions of contract, specification and bills of quantities, together with drawings and a spare copy of the bills of quantities, may be obtained on and after Monday, 19th December, 1932, from the Chief Engineer on production of an official receipt for the sum of £10, which must be deposited with the Accountant to the Board and which will be returned on receipt of a bona fide Tender accompanied by all the above-named documents and drawings (with the exception of the spare copy of the bills of quantities, which may be retained by the tenderer). Such payments and applications must be made between the hours of 10 a.m. and 4 p.m. (Saturdays, 10 a.m. to 12 noon). Cheques must be made payable to the Metropolitan Water Board and not to individuals.

Tenders, enclosed in sealed envelopes, addressed to the Clerk of the Board and endorsed "Tender for Turbine Connections—Kempton Park Pumping Station," must be delivered at the offices of the Board (Room 122) not later than 11 a.m. on Monday, 9th January, 1933.

The Board do not bind themselves to accept the lowest or any Tender.

C. F. STRINGER,
Clerk of the Board.

Offices of the Board,
175, Rosebery-avenue, E.C.1,
5th December, 1932. 9246

The Municipal Council of Nairobi

REQUIRE a QUANTITY of FIRE-CLAY SEWER PIPES, particulars of which can be obtained from the Council's London agents, CARTERS (MERCHANTS), Ltd., 39, New Broad-street, London, E.C.2. The Council does not bind itself to accept the lowest or any Tender. 9242

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London County Council.

THAMES FLOOD PREVENTION WORKS.
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TENDERS are INVITED for the WORK of ALTERING and STRENGTHENING the PARAPETS, STEPS, &c., along the Victoria and Albert Embankments.

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Remittances by post should be addressed to the CHIEF ENGINEER (A), The Old County Hall, Spring-gardens, S.W.1. Personal enquiries at Room 2, No. 3, Warwick House-street, Cockspur-street, S.W.1.

The contractor will be bound to observe the provisions of a fair wages clause, the terms of which are set out fully in the instructions for Tender and form of contract and in "The London County Council Gazette."

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E.1, after 4 p.m. on Monday, 2nd January, 1933, will be considered.

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A Seven-Day Journal

Memorial to Sir Charles Parsons.

ON Friday afternoon, December 2nd, a bronze memorial tablet to the late Sir Charles Parsons, erected in the offices of the Parsons Marine Steam Turbine Company, Ltd., at Turbinia Works, Wallsend, was unveiled by Mr. R. J. Walker, the chairman and managing director of the company. Opening the proceedings, Mr. Walker stated that, as representatives of the various departments of Turbinia Works, they were met together that afternoon with Lady Parsons and others to witness the unveiling of a memorial to their late chairman and illustrious chief, the inventor of the steam turbine engine and the founder of Turbinia Works. Much had been written and would continue to be written on Sir Charles and his life's work, a work with which they were all so intimately acquainted, and memorials might be erected in other parts of the country, but as the birthplace of the famous "Turbinia," and the pioneer establishment for the manufacture of marine steam turbines commercially, the directors of the company decided that a fitting memorial should be erected in the offices at Turbinia Works to perpetuate the memory of Sir Charles so that his great work and wonderful genius might serve as an inspiration, not only to engineers of the present generation, but to those who came after. The memorial, which was designed and executed by Mr. Herbert Maryon, Master of Sculpture at Armstrong College, Newcastle-on-Tyne, is a bronze tablet containing a portrait of Sir Charles in relief; an inscription below the portrait is balanced by a panel above, which shows the famous "Turbinia" steaming at full speed. Pilasters on either side, decorated with ornaments derived from marine plants and fishes, are surmounted by half figures of men engaged in setting turbine blades and in gear-cutting. The bronze panel was cast at the foundry of Mr. A. B. Burton, at Thames Ditton, Surrey, and is mounted on a slab of green marble from Connemara.

Ultra Short Wave Wireless Communication.

IN a lecture on ultra-short wave wireless communication, delivered at the Royal Institution of Great Britain, on Friday, December 2nd, the Marchese Marconi described the important results of his investigations into the properties and behaviour of very short electric waves. In 1896, he explained, he was able to demonstrate to the Post Office that waves in the neighbourhood of 30 cm., now sometimes called micro-waves, could be successfully used for telegraphic communication over a distance of 1½ miles by employing suitable reflectors. Eighteen months ago he decided again to take up the systematic investigation of the properties and characteristics of very short waves. Soon after a duplex demonstration over a distance of 23 miles between Santa Margherita and Sestri Levante, the Vatican authorities decided to adopt the new system for telephonic communication between the Vatican City and the Palace of His Holiness the Pope at Castel Gandolfo. The most outstanding result of all his tests was the successful establishment of communication from Rocca di Papa to Cape Figari, Sardinia, over a distance of 168 statute miles on a wave length of 57 cm. Not only were all previous distance records of communication by means of wave lengths below 1 m. thus far surpassed, but it was effectively demonstrated that these very short waves could overcome the supposed obstacle presented by the curvature of the earth, the distance between the two stations being considerably in excess of the optical range. The permanent and practical use of micro-waves on the Vatican Castel Gandolfo links provided the first example of what would be a new and economical means of radio communication, free from electrical disturbances, eminently suitable for use between islands, and to and from islands and the mainland, and also between other places separated by moderate distances. By virtue mainly of its sharp directive qualities the new system offered a high degree of secrecy, and as regards range the last word had not been said.

An Important Road Roller Development.

THE announcement is made that Mr. Edward Barford, in conjunction with Ruston and Hornsby, Ltd., of Lincoln, Grantham, and Stockport; Ransomes, Sims and Jefferies, Ltd., of Ipswich; and R. A. Lister and Co., Ltd., of Dursley, has made arrangements to purchase the business of Barford and Perkins, Ltd., and Aveling and Porter, Ltd., both of Rochester, from the receiver in charge of the interests of Agricultural and General Engineers, Ltd., which company at present owns their share capital. A new company, the name of which has yet to be decided, is to be formed to develop the goodwill and trade connections of the existing companies which were not affected by the collapse of Agricultural and General Engineers, Ltd., and have since been working independently of that company with continued success. The chairman and managing director of the new company will be Mr. Edward Barford, who is the chairman of both the existing companies and has been largely responsible for the building up of the position held by Barford and Perkins, Ltd., in the motor road roller business and establishing the world-wide reputation the firm now enjoys. The road roller business is British in origin, and the first steam roller was built in 1867 by Aveling and Porter, while Barford and Perkins have developed the oil engine-driven roller. We are glad to learn that the businesses of these two old-established companies, which to-day deal with three-quarters of the home road roller trade and are recognised as the largest manufacturers of this class of machinery in the world, are to be preserved and further developed under Mr. Edward Barford's control.

The Retirement of Mr. T. H. Woollen.

THE announcement is made that Mr. T. H. Woollen, M.I. Mech. E., M.I.A.E., who since 1922 has been in charge of the Standards Department of the Society of Motor Manufacturers and Traders, Ltd., later transferred to the Institution of Automobile Engineers, will retire at the end of the year. In the early stages of his career Mr. Woollen was associated with the Sheffield steel industry. He subsequently did invaluable work in the rim and the pneumatic tire industries. In 1906 he was made managing director of Clement Talbot, Ltd., and from that time onwards continued to interest himself in all matters relating to the standardisation of parts, both in the cycle and the motor industries. During the war he was Director of Agricultural Machinery at the Ministry of Munitions. In 1922 the Council of the Society of Motor Manufacturers and Traders requested him to take full responsibility for the standardisation of automobile parts outside the scope of the then British Engineering Standards Association. This he did and has continued to do with the greatest success. His work has brought him into close connection with Government Departments, the Army, and the India Office, and he has been head of the technical departments of the Institution of Automobile Engineers since 1931, when the work of those departments was, in July of that year, transferred to the Institution by the Society of Motor Manufacturers and Traders, Ltd. His widespread activities have gained for him a large number of friends in the industries which he has for so many years loyally served, and we hope that he may yet enjoy many years of well-deserved and happy retirement.

The Heating and Ventilating Industries.

AT the invitation of the employees in the heating, ventilating, and domestic engineering industries, employers have been meeting them during the past three months in an endeavour to solve, by common effort, problems arising out of business depression. The relations of masters and men in these particular industries have always been notable for unusual cordiality. Consequently the approach of the men was welcomed and steps were taken immediately to appoint delegates from both parties. First of all, difficulties were tabled, recommendations were made, branches throughout the country consulted, their opinion laid before the main conference, and, in most cases, solutions satisfactory to both sides agreed upon. The scope of the deliberations included not only wages and hours of labour, but the question of apprenticeship, suggested alterations in the system of promotion from the lesser-skilled ranks of employees, the observance of rules relating to working conditions throughout the country, the employment, wherever possible, of local labour, and the severe competition with which the industry is faced. In view of this competition the advisability of launching a scheme of propaganda was considered, and it was felt by the representatives of the operatives' union that as the union was interested in the development of the industry in the same way as the employers, they would like to consider whether they could make some contribution towards the cost, in the event of such a campaign being carried out.

A British Shipping Policy.

A REPORT which has been drawn up by the Chamber of Shipping of the United Kingdom deals with shipping policy, particularly in relation to the forthcoming World Economic Conference. Annexes to the report are being placed before the Government as a confidential paper. In the 1929 report it was estimated that in that year British shipping represented about 40 per cent. of the total tonnage then available for carrying the world's international seaborne trade and that it was then carrying about 43 per cent. of that trade. For the first eight months of the present year the Board of Trade returns show that Great Britain's foreign trade is only 64 per cent. in value of that of the corresponding months of 1929 and its estimated volume in weight only 77 per cent. Tested by both tonnage expenses and earnings, the shipping policy of the Committee of the Chamber estimates that inter-Empire trade finds employment for only a little over one-third of the British tonnage available for overseas trade, and the remaining two-thirds find employment in trade between this country, the Empire, and foreign countries. Unless these trades are re-established there appears to be no future for the British mercantile marine as it exists to-day. Free access to open markets is advocated with lessened subsidies. In the above-mentioned annexes reference is made to methods of reservation, restriction, and discrimination which may or can be put into force if Great Britain be forced to abandon its traditional policy of freedom of the seas and access to all ports on terms of quality. It is recommended that at the World Economic Conference Great Britain should seek to secure the co-operation of as many nations as possible pledged to work for the re-establishment of world trade through the removal of trade barriers, the modification of tariffs, and the removal of all forms of discrimination.

The Engineer-in-Chief of the Post Office.

ON Wednesday, November 30th, Colonel Sir Thomas F. Purves retired from the office of Engineer-in-Chief of the Post Office after more than forty-three years of Government service. He is succeeded by Lieut.-Colonel A. G. Lee. Sir Thomas was born at Blackadder Mount, Berwickshire, on December 31st, 1871. He entered the Civil Service in 1889, and was transferred to the Engineering Department of the Post Office in 1892. In 1900 he became Technical Officer on the Headquarters Staff, Assistant Superintendent Engineer five years later, and Staff Engineer in 1907. In 1919 he was appointed Assistant Engineer-in-Chief, and became Engineer-in-Chief in June, 1922. He served in the Royal Engineers during the war, and adapted electrical communication systems for Army use, visiting the fronts and acting as Liaison Officer between the British Expeditionary Force and the General Post Office. He presided over the Post Office Engineering Department throughout a long period of unparalleled technical progress at home and abroad on both telephone and telegraph work. His geniality and good humour have gained him many friends in Great Britain and in the many Continental and overseas countries with which he was called upon to collaborate, all of whom will join us in wishing him a long life of continued prosperity and happiness.

Portuguese Naval Orders.

ACCORDING to a Lisbon report, the Portuguese Cabinet has decided to place orders for several naval vessels, but the 5100-ton aircraft carrier is not to be proceeded with. The contract for two sloops will be placed with R. and W. Hawthorn, Leslie and Co., Ltd., of Hebburn-on-Tyne, which firm, it may be recalled, recently launched a Portuguese sloop from its Hebburn yard. The order for two submarines, probably of 864 tons each, will be placed with Vickers, Armstrongs, Ltd., of Barrow-in-Furness, where the ships will most likely be built and engined. Reference is also made to the placing of the order for a destroyer with Yarrow and Co., Ltd., of Scotstoun, Glasgow. Out of the forty-three firms invited by the Portuguese Government to submit tenders, only seventeen complied with the necessary conditions, and of that number six, it is interesting to learn, were British.

The Northampton Polytechnic Institute.

ON Friday last, December 2nd, Prince George opened the new building which forms an extension to the Northampton Polytechnic Institute, E.C.1. He was formally welcomed by Mr. H. A. Game, Chairman of the Governing Body, and was conducted over the new buildings. In the course of a speech, Prince George referred to the great value of technical training for industry, and announced that the Duke of Connaught had given his consent to the request that the building be known as the Connaught Building. The extension occupies part of a site, with street frontage on three sides, facing the main Polytechnic building. It has been designed to accommodate the following sections, namely, Chemistry, Watch and Clockmaking, Furriery, Lens Workshop and Automobile Laboratories, whilst a number of lecture-rooms and class-rooms are available for general use. It comprises a basement, a ground floor, and four storeys above; the total floor area is approximately 28,000 square feet. The building, which, apart from site, furniture and equipment, has involved an expenditure approximating to £45,000, occupies rather more than half the available site, and has been so designed as to permit of easy extension. With the new building in service it is intended, so far as funds will permit, to proceed with a certain amount of reorganisation within the main building, the space now set free by the transfer of sections to the extension making possible considerable expansion in other directions, particularly in the provision for instruction in engineering and physics. The opening ceremony was followed by the annual prize distribution, and the Principal, Mr. S. C. Laws, gave a report on the work which has been done at the Institute during the past year.

The Hoover Dam on the Colorado River.

No. I.

THE Hoover Dam project was authorised primarily to control the flood waters of the Colorado River, so that they would not attain destructive force further downstream. The next object was to conserve the abundance of the flood periods, so that a fairly uniform volume of water could be counted upon by the areas depending upon the Colorado for irrigation. Some means of control was urged intermittently for a quarter of a century before the Hoover Dam project was approved by Congress.

The Imperial Valley—see Fig. 1—lying mainly in the southernmost part of California, has been developed for agriculture since 1900. The valley is a great basin which once was the head of the Gulf of California, but which became isolated from that arm of the sea by the westward spread of the Colorado's delta. In time, the impounded water was evaporated by the strong action of the sun until nothing was left of it but what is now known as the Salton Sea, which fighting the Colorado. On the other hand, low water in 1924 occasioned a crop loss in the Imperial Valley estimated at 6,000,000 dollars. The Hoover Dam project is counted upon to stabilise the river's flow and to prevent those extremes that threaten life and property on one hand and crops on the other.

The Colorado River has a length of 1700 miles from source to mouth, and a watershed area of 244,000 square miles. Three-fourths of the river's flow originates in the snow-clad mountains that form the northern slopes of the basin. The river's discharge, measured at Yuma, Arizona, has varied from 66 to 200,000 second-feet. In the canyons, covering a distance of 500 miles, the Colorado drops 3000ft. Driftwood has been found on ledges more than 100ft. above the normal level of the stream. Because of the nature of the area drained and the erosive violence of the river when in flood, the Colorado carries seaward enormous quantities of silt. If compacted, this silt in the course of a year would form a volume of 170,000,000 cubic yards. The silt continually upbuilds and widens the delta of the Colorado; and the river is known to raise its bed as much as 10ft. in a single twelvemonth. Since the white man first surveyed the lower reaches of the stream, the channel and Black Canyon; and Black Canyon was selected. The reasons are thus stated in the official report:—

"In general, geologic conditions at Black Canyon are superior to those at Boulder Canyon. The Black Canyon site is more accessible, the canyon is narrower, the gorge is shallower below water level, the walls are steeper, and a dam of the same height here would cost less and would have a somewhat greater reservoir capacity. The rock formation is less jointed, stands up in sheer cliffs better, exhibits few open fractures, is better healed where formerly broken, and is less pervious in mass than is the rock of the other site. The Black Canyon rock is not so hard to drill as that of Boulder Canyon; and it will stand better in large tunnel excavations with less danger to the workmen. There is no doubt whatever but that the rock formations of this site are competent to carry safely the heavy load and abutment thrusts contemplated. It is well adapted to making a tight seal and for opposing water seepage and circulation under and around the ends of the dam. It ensures successful tunnelling, and, so far as the rock is concerned, the general safety and permanence of the proposed structure."

The foundation rock is technically classified as andesite tuff breccia, and is the product of volcanic

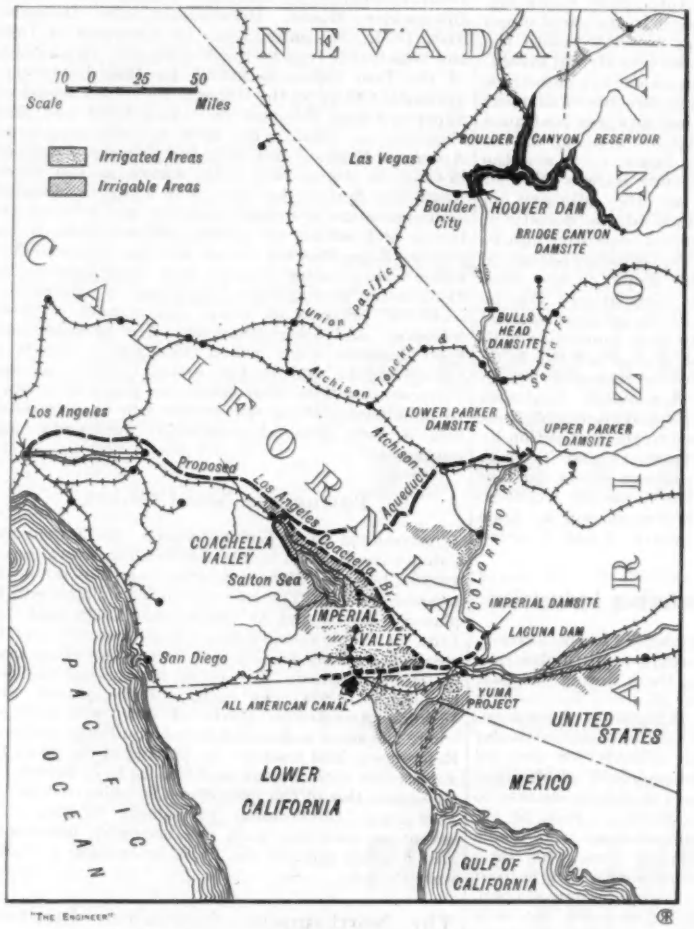

FIG. 1—MAP OF COLORADO RIVER AND IMPERIAL VALLEY

FIG. 2—MAP OF HOOVER DAM AND BOULDER CITY DISTRICT

occupies the deepest section of the valley. The valley slopes toward this point, which is about 300ft. below the normal level of the Pacific Ocean. The Colorado River cuts through its delta on its seaward course at an elevation of approximately 100ft. above sea level; and because of the alluvial character of the delta, and the recurrent floods of the river, the Colorado is in a continual state of unstable equilibrium.

Since water was first diverted to promote the growing of crops in the arid region of the Imperial Valley, the cultivated area has expanded until it is now 500,000 acres, upon which 75,000 people live and work. The marketable crops now have an annual value of substantially 100,000,000 dollars, and consist largely of foodstuffs which are of a seasonal character. In a sense, the Colorado created the Imperial Valley, but on more than one occasion the river has threatened to turn itself into the valley and reinundate it. Since 1900 the Colorado has several times broken through the defensive embankments, and has sent some of its flood waters into the basin. One such instance occurred near the close of 1904. The breach was not mended until February, 1907, and the battle, a desperate one, entailed an outlay of 2,000,000 dollars. During that interval, the surface of the Salton Sea was raised 73ft., and the superficial area was increased from 249 to 470 square miles. The invading flood cut new channels in the valley ranging from 30ft. to 40ft. in depth, and in some places having a width of 1000ft. The river again forced its way into the valley in 1909, and did a great deal of damage. Up to date, the people of the section and the Federal Government have expended 7,000,000 dollars in of the Colorado has changed radically a number of times. The foregoing facts should make plain why there is urgent need to control this remarkable river.

COLORADO RIVER PROJECT.

The Colorado River project, as approved by Congress in December, 1928, is designed to serve six purposes. These are:—Control of floods, improvement of navigation, regulation of flow, irrigation development, domestic water supply, and generation of power. These ends will be served by the building of the Hoover Dam, the construction of the associated hydro-electric plant, and the digging of the All-American Canal. We shall not touch further upon the latter feature other than to say that at the present time the water that is drawn off for the irrigation of the Imperial Valley flows first into Mexico and then northward into California. The new canal will be wholly within the United States and follow a different course.

The present undertaking is the outcome of the Colorado River Compact, signed on November 24th, 1922, in which seven States joined, namely, Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming. By that agreement, the average annual flow of the river was apportioned so as to meet present needs as well as liberally estimated future requirements. There still remain 4,000,000 acre-feet of water unassigned; and this volume will be apportioned in the years to come as circumstances dictate. Accord having been reached in this essential particular, a board was next organised in May, 1928, to choose a dam site in the canyon section of the river. The choice rested between Boulder Canyon eruptions, the last of which probably occurred thousands of years ago. Time has since cemented the breccia, and has formed it into a tough and durable mass capable of resisting erosion and of withstanding the weather remarkably well. Part of the exploratory work done by the United States Geological Survey consisted of sinking a considerable number of holes in the rock underlying the river bed. The deepest of these holes reached 557ft. beneath the low-water surface of the rock, and even at that depth no other rock formation was penetrated.

While the choice of Black Canyon was influenced by its physical and geological advantages, there was yet another weighty reason for deciding to build the Hoover Dam in the canyon section of the river. The structure had to be placed so that its associated power plant would be within economical distributing distance of markets for the generated current. This feature was essential because a condition precedent to construction was the assured sale of power so as to repay the cost of the Hoover Dam and power plant within a span of half a century. The output has already been contracted for.

THE DAM.

In broad terms, the Hoover Dam—see Figs. 3 and 4—will be an immense wedge of concrete so formed that it will tie together the flanking walls of a box canyon that has a depth of about 1000ft. The dam will be of the arch-gravity type. From base to crest it will have a height of 727ft. The spread of the base, parallel with the stream, will be 650ft., and the crest of the dam, which will have a width of 45ft., will be 1180ft. long. The dam is to be keyed to the

supporting bed rock at a depth of 150ft. beneath the low-water level of the river. By itself the dam will contain about 3,400,000 cubic yards of concrete, and the power plant and other appurtenant works will require the placing of an additional 1,000,000 cubic yards of concrete. The basin above the dam will extend upstream 115 miles, have a shore line of 550 miles, and a storage capacity of 30,500,000 acre-feet of water. The reservoir will be able to hold a two-year flow of the Colorado, and at its topmost level the lake will have a maximum depth of 580ft.

Silt will accumulate in the basin at a rate variously estimated at from 80,000 to 250,000 acre-feet annually, and it is assumed that the total silt deposited in the course of fifty years will not exceed 3,000,000 acre-feet. Government engineers have calculated that a span of more than 200 years would be required to fill the reservoir with silt. If, however, other dams, as now contemplated, are built farther upstream, the quantity of silt reaching the Hoover Dam reservoir will be reduced accordingly. The water re-entering the Colorado from the Hoover Dam reservoir will be much cleaner than heretofore and far better suited for domestic consumption or for irrigation than the present flow. The expectation is that the river below the dam will purge itself of silt in the course of a decade and produce a river bed of clean sand and gravel. Los Angeles and a group of associated cities count upon this transformation and will shortly begin the construction of an aqueduct that will tap the Colorado and carry water from it a distance of 265 miles.

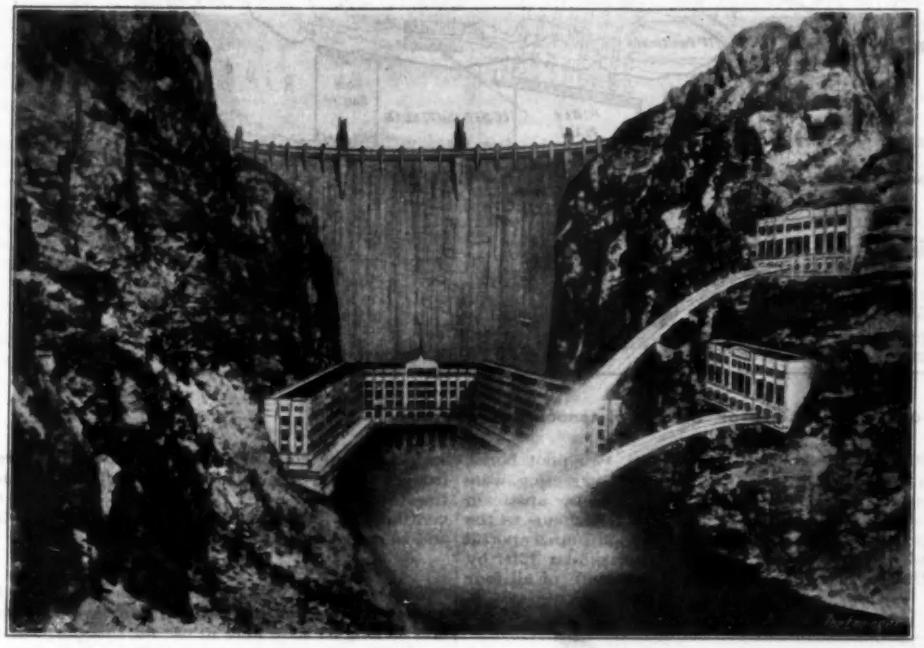

FIG. 3—PROBABLE APPEARANCE OF FINISHED DAM FROM DOWNSTREAM

POWER PLANT.

Within the power plant at the Hoover Dam will be installed seventeen turbines operating under an average head of 520ft. The rated capacity of the plant will be 1,800,000 horse-power. Tentative plans for equipment call for fifteen turbines, each of 115,000 horse-power, and two each of 55,000 horse-power, which will drive fifteen 82,500-kVA and two 40,000-kVA generators. The output of the plant will be 663,000 continuous or "firm" horse-power. For firm horse-power, the immediate purchaser will pay at the rate of 1·63 mills* per kilowatt-hour. At high-water periods with a head possibly as great as 582ft. the generators will produce their maximum output, and this seasonal excess current will be sold for 0·4 mill per kilowatt-hour. Industrial activities of all sorts will benefit by this low-priced energy, but mining properties lying within economical distributing distances in neighbouring California, Arizona, and Nevada will be helped especially.

* A "mill" is the thousandth part of a dollar.

COST.

The cost of the entire undertaking, as now projected, can be itemised as follows :—

	Dollars.
Dam and reservoir	70,600,000
1,000,000 H.P. development	38,200,000
All-American canal	38,500,000
Interest during construction	17,700,000
Total	165,000,000

How, the reader will ask, can the enterprise pay for itself ? Dr. Elwood Mead, Commissioner, Bureau of Reclamation, has answered the question as follows : "The power and water income from the contracts already signed will, in fifty years, bring an income of 373,500,000 dollars. Of this, the United States will receive 228,260,000 dollars to repay money advanced, with interest. Arizona and Nevada will each receive 31,235,000 dollars. Operation and maintenance will absorb 16,120,000 dollars, and there will be a surplus of 66,650,000 dollars, which will be the net profit of the Government for going into this enterprise. This sum will be disposed of as Congress may hereafter direct."

Under the terms of the contract signed on April 20th, 1931, the successful bidder, Six Companies, Incorporated, must finish the dam within six and a-half years. The contract price is 48,890,995·50 dollars. Six Companies, Incorporated, is composed of six contracting firms that, before their combination, had executed contracts having an aggregate value of more than 400,000,000 dollars and had in hand, at the time of signing, work having a value of 30,000,000 dollars. These associated concerns had constructed railroads, highways, dams, and hydro-electric plants, had driven tunnels, built bridges, and carried out various other large undertakings. By accepting the Hoover Dam contract Six Companies, Incorporated, undertook to go into a veritable desert, a good many miles from the nearest railway, and there to create an operating centre, build roads to a well-nigh inaccessible site, and do many and divers things —most of them difficult—so that work on the project could be started and then continued at a rapid rate. On its part the Government pledged itself to furnish cement and structural steel, so that the contractor is protected against any fluctuation in prices.

THE SITE.

The site for the Hoover Dam—see Figs. 1 and 2—is about 25 miles to the south and east of Las Vegas, Nevada, which is the nearest station on the Union Pacific Railway. That line built a 22-mile branch to link its tracks with Boulder City, a new town fathered by the Federal Government and managed by the Bureau of Reclamation. Boulder City is situated about 7 miles west of the dam site and was placed on a ridge 2500ft. above sea level and 1000ft. higher than the rim of Black Canyon. The town site is swept by the free winds and is considerably cooler than the canyon where, during the past summer, the thermometer registered 128 deg. Fah. in the shade. The authorities have done everything practicable to make Boulder City a healthful and comfortable place for from 4000 to 5000 persons. In many particulars the community is thoroughly up to date. There are cooling systems in many of the administrative and municipal buildings, and 93 per cent. of the homes are equipped with electric refrigeration. The water supply for Boulder City is pumped up from the Colorado River. The supply is ample enough for domestic purposes and to permit the sprinkling of gardens, lawns, and ornamental shrubbery planted to offset the natural barrenness of the desert. Boulder City is expected to be the permanent abode of several thousand people directly or indirectly identified with the activities at Hoover Dam, and provision will be made for tourists and other transient visitors.

To make Boulder City accessible to the dam site, so that workers could be moved to and fro and materials delivered at working points, the Government built a railway nearly 10½ miles in length—the length indicating the tortuous route followed in negotiating the climb between the river and Boulder City. The maximum gradient is 5 per cent., and the ruling gradient is 3 per cent. The railway cost 455,509·50 dollars. In its construction 900,000 cubic yards of earth and 202,000 cubic yards of rock were excavated, and five tunnel sections, having a combined length of 1705ft., were driven. Electrical energy for construction and other purposes reaches Boulder City and the dam site by a transmission line 225 miles long, built especially for the purpose so as to tap the system of the Southern Sierra Power Company, at Victorville, California. When power comes to be generated at the dam, this permanent line will carry current in the opposite direction.

RIVER DIVERSION.

Before any work at all can be done on the dam itself, the river must be diverted, and the means of diversion must be ample enough to accommodate the flood waters of the Colorado. To this end, four tunnels—see Fig. 5—50ft. inside diameter when lined, are counted upon to carry off the water when the channel of the river is blocked by a great cofferdam 80ft. high. The cofferdam is considered "the one hazardous feature of the project." Plans for this structure have been prepared by the Bureau of Reclamation, and the Government assumes responsibility should it fail or should the cofferdam be overtopped by exceptional floods. Upstream from the discharge ends of the diversion tunnels there will be a second cofferdam that will serve to keep the Colorado from backing up upon the site to be cleared for the foundation of the dam. The excavation for the foundations will require the removal of about 7,000,000 cubic yards of material. To date, Six Companies Incorporated has driven the four diversion tunnels which, unlined, have diameters of 56ft. The lining is now going forward rapidly.

There are two diversion tunnels on each side of the river, and they follow the courses indicated in Fig. 5. Each tunnel differs in length, the longest being 4300ft. and the shortest 3560ft., and the aggregate length is 15,909ft. From intake to outlet, each tunnel has a gradient of approximately 14ft., and the lower lip of each tunnel is several feet below the normal water level of the stream. In driving the tunnels, nearly 1,500,000 cubic yards of rock were excavated. Tunnelling was started in May of 1931, but not, as might be expected, at the planned

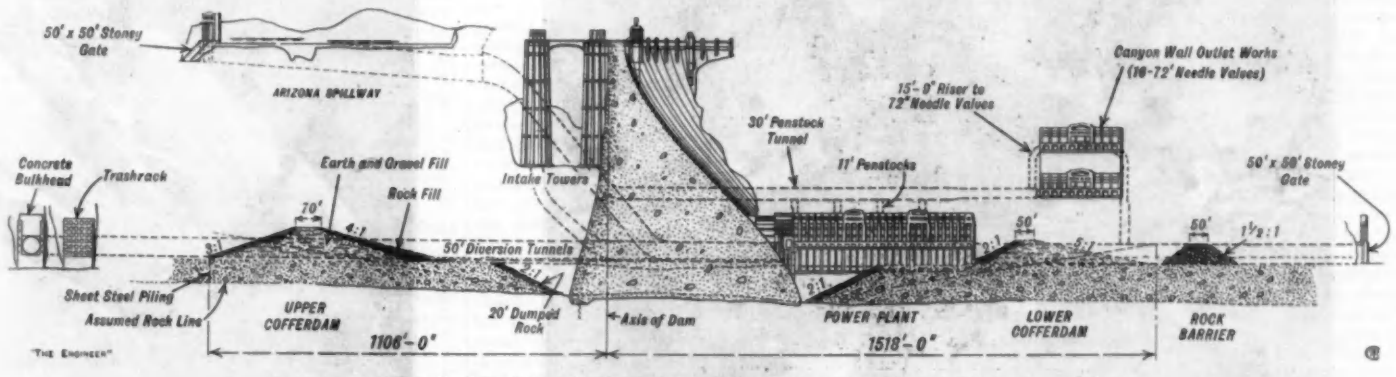

FIG. 4—SECTIONAL ELEVATION OF MAIN DAM AND COFFER DAMS

positions of the portals. Work was begun at the mid-length of the two tunnels on the Arizona side of the stream, where Nature, fortunately, had provided a narrow shelf on which drill runners could set up their tools. Operating air for the drills was furnished by portable air compressors, which, with the equipment for a blacksmith shop and other necessary apparatus, were floated 2 miles down to a position near the dam site, where a slide of broken rock provided both a landing place and room for the compressors and the associated outfit. The barges were drawn back upstream by cables attached to them when they made their trips downward.

The first of the drill holes for the Arizona adit were driven on May 12th, 1931, the work being carried thence inward with Ingersoll-Rand drifters and "jackhammers." The Arizona adit, like the Nevada adit, was 10ft. by 12ft. in cross section. The spoil from the Arizona adit was moved to the portal in 1 cubic yard dump cars and dumped just outside to form an ampler shelf for the accommodation of other apparatus. A foot bridge, suspended from a cable, was next thrown across the river to the Nevada wall, where a bench was drilled and blasted to facilitate the driving of a 10ft. by 12ft. adit that would intersect, at their top sections, the lines of the two diversion tunnels to be driven on the Nevada side. The Arizona adit penetrated the canyon wall for a distance of 826ft., while the Nevada adit was 630ft. long. At each intersection, two pilot bores, serving as top headings, 12ft. by 12ft. in section, were started in opposite directions—that is, upstream and downstream. When the rock contiguous to the designed positions of the diversion-tunnel portal had been cleared away sufficiently, similar 12ft. by 12ft. headings were started at both ends of all four tunnels. The removal of a considerable amount of interfering rock was necessary before the pilot headings at the portals could be begun. The portal top headings were first started at the lower ends of the two diversion tunnels lying next to the face of the canyon on either side of the river. The top headings for the upstream portals were begun later.

Exploratory drilling had determined with reasonable finality the character of the rock to be pierced by the diversion tunnels, and it was known that the andesite tuff breccia would break up fairly well, although it was classed as "dead" and requiring a comparatively close spacing of the drill holes to ensure satisfactory fracture. Nevertheless, one purpose of the top headings was to disclose on a satisfactory scale the true condition and character of the rock from end to end of each diversion tunnel. In addition, the top headings were designed to facilitate the ventilation of the tunnels during their construction and to make access to them easy.

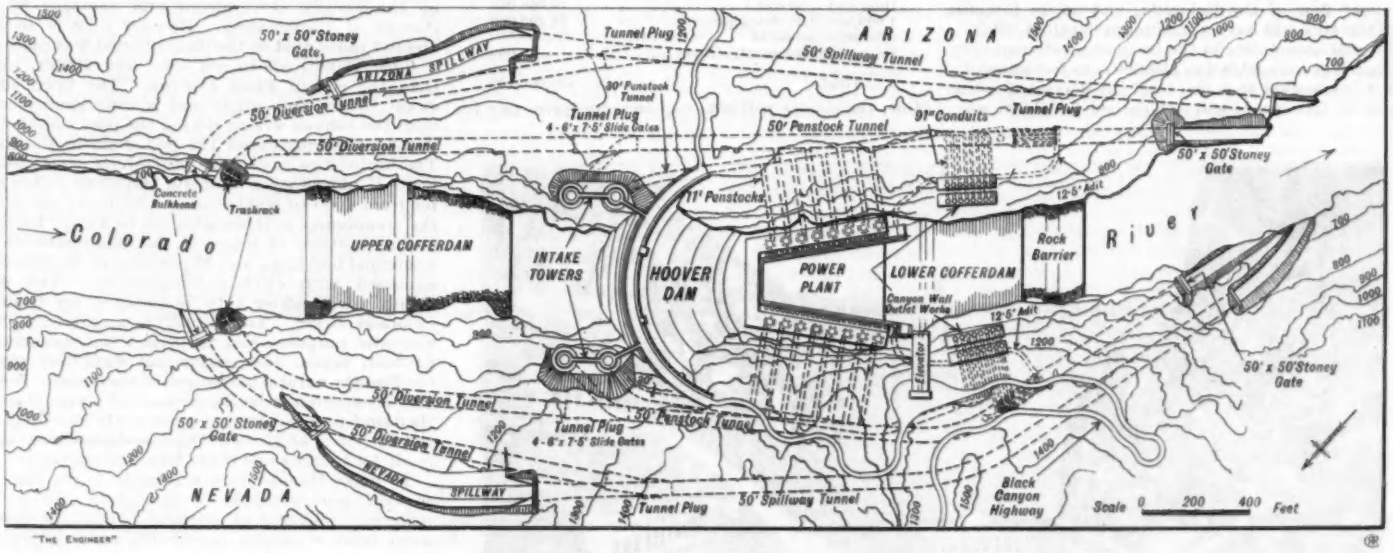

FIG. 5—GENERAL LAY-OUT OF DAM AND ASSOCIATED WORKS

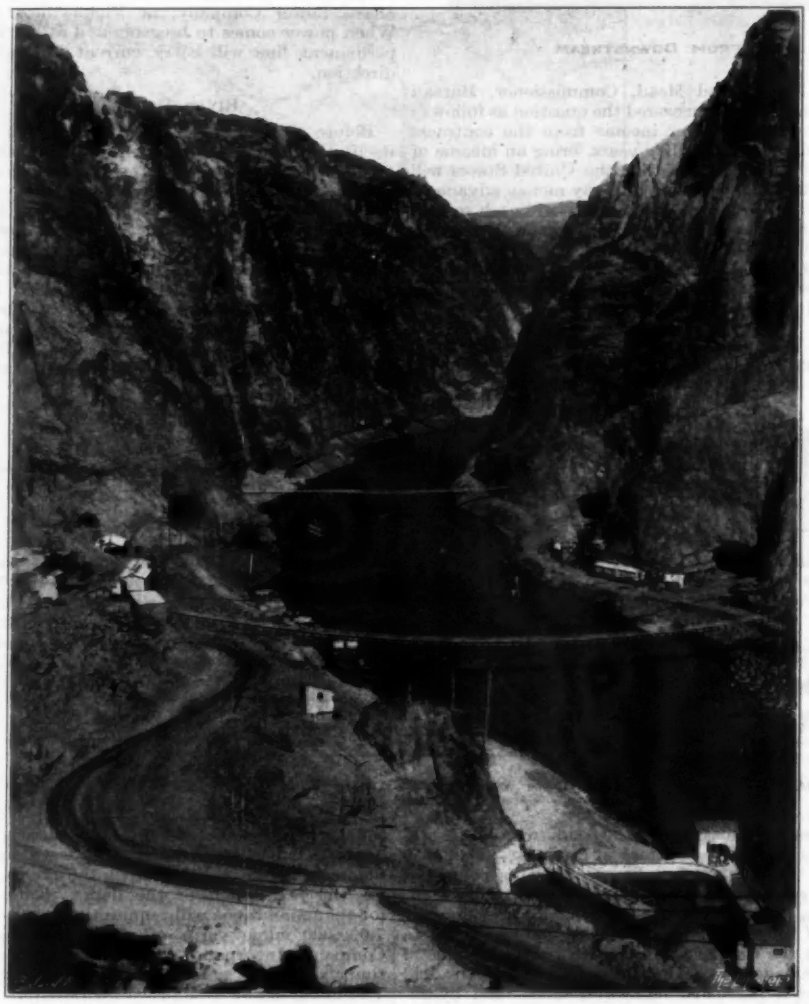

FIG. 6—VIEW UPSTREAM SHOWING DIVERSION TUNNEL OUTLET PORTALS

THE ADITS.

The two adits provided the means by which the greater part of the top-heading footage was driven, and as long as they were in use for this purpose, the spoil was removed by way of them and dumped along the canyon walls so as to form the foundations for roads linking the adits with the lower portals of the tunnels—see Fig. 6. Conway mucking machines, electrically driven, loaded 3½-cubic yard Western dump cars which were moved to and fro by 10-ton Baldwin-Westinghouse storage-battery locomotives. When the adits were started, electric current was not available on the project, but as soon as it was obtainable and suitable electrically driven stationary compressors were in position, the drilling of the top headings was done with an installation consisting of a carriage at each heading equipped with two horizontal bars, one above the other, with two Ingersoll-Rand drifters on each bar. The drill carriage was set up on the narrow-gauge rails used by the spoil trains. A drill round varied from twenty-four to twenty-eight holes, the holes being 10ft. deep, and the break per round averaged about 8·5ft. The crews alternated between neighbouring top headings—drilling at one while the spoil was being removed at the other, and work was carried on continuously in three shifts daily, each of eight hours' duration. With the crews well trained and

FIG. 7—SCALING CANYON WALLS ABOVE TUNNEL PORTAL

conditions favourable, some of the top headings were advanced by as much as 30ft. in the course of twenty four hours. The best progress made in a single month in advancing the top headings aggregated 4147ft. The rock from all the top headings amounted to 84,815 cubic yards, the headings having a combined length of 14,637ft. An average of about 9 lb. of dynamite was used for each cubic yard of rock excavated, or approximately 765,000 lb. for the four headings.

After a good deal of open-cut excavating had been done and the canyon walls had been scaled to remove loose and menacing rock in the vicinity of the lower portals—see Fig. 7—the driving of large sections of the diversion tunnels at the exposed rock faces was begun. These tunnel sections were approximately 41ft. in height and 56ft. in width—leaving untouched the segment of the invert section, 15ft. in height at the centre line. The procedure differed somewhat at the several faces or headings, depending upon whether or not the top or pilot heading had been driven. The lower portal of one of the tunnels on the Arizona side was the first to be attacked in driving a 41ft. by 56ft. section, and work on it was started shortly after September 15th, 1931. As it happened, the top 12ft. by 12ft. heading had not been holed through in its advance southward from the adit. Accordingly, a 12ft. bench was driven to a depth of one round in the arch, and was then widened out and deepened so as to form a bench 30ft. in height. With this bench removed by drilling and blasting, the excavation had the shape of a horseshoe, with a maximum width of 56ft., and a height at the centre line of about 42ft. This was called a bench heading, in contradistinction to the comparatively small top or crown heading, which has been previously described.

(To be continued.)

Statistics and Engineering.

By DUDLEY W. WALTON, F.S.S.

No. I.

THE school-boy who described the slide rule as a "guessing stick" indicated the fundamental difference between mathematics and statistics. A statistical result comes from scientific and systematic guessing. It determines most-probable values. In mathematics guessing is not allowed. The mathematician starts from axioms and makes deductions. Statistics commence with observed or estimated measurements, examine the data for their acceptability, and deductions follow. For some statistical operations the inductive method, inquiring into causes or probable causes, is available. A value derived by extrapolation from an engineer's smoothed curve is an induction. Of such an extrapolation a statistician will say that it is the most probable value, subject to a stated plus or minus correction.

IDEALISATION AND INTERPRETATION.

While mathematics idealise a given situation, statistics infer the ideal from a multitude of admittedly unsatisfactory observations, as, for instance, when a line of least squares is drawn through a number of points. Statistics also establish fundamental methods of interpreting data. The familiar formula for calculating the time of the swing of a pendulum $t=\pi\sqrt{\frac{l}{g}}$ idealises the motion of a pendulum, it not being possible to construct a pendulum which conforms exactly to the "law," with the further difficulty of the incommensurability of π and the impossibility of determining absolute length. Likewise many statistical formulæ assume an ideal association of events which does not exist in the natural world. The normal curve derived from the formula $\frac{dy}{dx}=kxy$ idealises the normal distribution of a large number of "sample" observations. Other curves of this kind, especially those derived from the binomial $(p+q)^n$ idealise the relationship of a statistical series.

AN ENGINEERING EXAMPLE.

An engineering example of the statistical method is found in the case of the highly scientific guesswork which determines the tonnage of a large ship. Here is a quantity which cannot be measured, except perhaps by noting the displacement of water in a dock, but which can be computed with sufficient accuracy for all the purposes of navigation and commerce. A marine architect has been known to state the tonnage of a battleship to the nearest hundredweight! The statistician in dealing with a like quantity would give only significant or rounded figures. This is a case of applying the statistical method to aggregates not perceptible to the senses and making them perceptible to the mind.

PROBLEMS OF RELATIVE ACCURACY.

Mathematicians and statisticians both admit the merely relative accuracy of actual measurements, or of computations derived from measurements. Many actual measurements go far beyond all practical needs of accuracy. The value of π has been calculated to thirty-six places of decimals. In regard to π, the statistician uses the most probable value, according to the needs of the case to which it is applied. The π point on a slide rule is usually sufficiently accurate. The value assigned to the length of the tropical year, viz., 365·24220 mean solar days, is calculated to within one-hundredth part of a second. An additional decimal place would be of no utility in correcting a chronometer, even though it is possible by mechanical means to measure still smaller intervals of time.

A recruiting sergeant will aver that a recruit has never been measured who is exactly six feet tall, with the fallacious corollary that a man never is exactly six feet tall. The most accurate measurement that can be made with the finest instrument is never absolutely correct. A micrometer is relatively a coarse instrument. The standard British yard is never found to be exactly thirty six inches. When the standard yard is periodically retested for variation, the staff of the National Physical Laboratory have a sweepstake on the millionths of an inch by which the standard varies. Even with the most careful determination there is room for approximation in regard to the effect of temperature on the comparator. In his works at Detroit Mr. Henry Ford installed a unique set of step-by-step gauges, intended to determine for standardised fitting purposes a length to within a one-millionth part of an inch. In practice the device proved unsatisfactory because the approach of a human being to within several feet of the instrument caused it to give a false indication.

Atmospheric changes affect the adjusting screws of the transit instrument at Greenwich Observatory, and the effect can be allowed for in recording the time of transit of a star. It is said that the delivery of a ton of coals at the Observatory will affect, by its mass reaction, the rate of the pendulum of the master clock!

STUDY OF INDETERMINATE QUANTITIES.

Statistical methods provide a means of studying quantities, both large and small, which cannot be exactly determined. It is a *method* rather than a science, although the charter of the Royal Statistical Society refers to the "progress of statistical and economic science." This study of the relationship of such indeterminate quantities and measurements arose in the sixteenth century from the need of measuring social phenomena. Governments wished to ascertain, either for military or taxation purposes, what population was available or would be available at some future time. Nearly all the world's basic statistics are related to taxation and its effects, and we still use the word "population" in a technical sense for all the items in a statistical "universe," the characteristics of which are to be computed from "samples" of the population. There is, for instance, a population of motor cars in a given geographical universe, and from sample observations of the behaviour of cars when braked, a permissible road speed can be deduced, with further deduction of the distance from a speed-obstacle for the erection of a warning post.

DEVELOPMENT OF STATISTICAL METHODS.

While statistical methods were being developed at first by the treatment of social and latterly very greatly improved for the treatment of biological phenomena, the mathematical elements of statistics came largely from the study of the laws of chance. Gamblers having noted the recurrence of favourable events, enlisted, in the seventeenth century, the aid of mathematicians to examine the phenomena of dice and playing-cards. A great deal of work was done to formulate laws of chance, a curve of chance was generated, and many algebraic formulæ made available, not so much to assist gamesters, but to calculate the chances for and against a specified happening. The great Frenchman, Laplace, noticing some apparently erratic discrepancies in the calculated position of the moon, applied the laws of chance to celestial events, and one thing leading to another, developed his masterly Theory of Probabilities. To put his conclusions briefly and crudely, Laplace found that if events happened strictly by chance, the probability of an event occurring could be determined. There would be average results. If a penny is tossed one thousand times there will be approximately 500 heads and 500 tails. A gambler therefore would not lose a hazard if he went on to a point of equality. This is not what the gambler wants to know, and this is why "systems" applied to gambling, at Monte Carlo and elsewhere, always break down. Statistics cannot tell the gambler how to win. Experiences at Monte Carlo did at one time indicate the tendency for certain numbers to occur more frequently than others but this was due to a defect of the roulette apparatus; nowadays it is understood that the spindles are changed daily.

It was from these gambling investigations that actuarial science arose. *A priori* arguments showed that there must be an average length to that greatest of all chances, human life, and *a posteriori* observations, coming down from the social side of statistics, showed that the average length of life, within the limits of a plus and minus correction, corresponded with the *a priori* deduction as closely as fact agreed with theory in the case of tossing a penny. Hence, life assurance became possible. Applying the same argument to the recurrence of shipwrecks, or the expectation of life of a ship, marine insurance was established on a firm basis. British shippers owe an incalculable debt of gratitude to the genius and memory of Laplace, and in a symbolic sense Lloyd's Building is his monument.

MEASUREMENT OF TENDENCIES.

Statistics describe and measure tendencies. So far as the purpose of statistics is to discover trends and tendencies, it is not necessary to register the last detail. Rounding out thousands to the nearest ten, or millions to the nearest thousand, is legitimate and customary. This is why the accountant is never a good statistician. He demands figures correct to the nearest penny. Statistics is the science of revelation, while accountancy has been described as the science of concealment! Because of the fierce light which beats upon Somerset House, Government statistics are too often kept back for verification of detail. It suffices in the great majority of investigations to accept the influence of what are known as compensating errors. A little more in some measurements balances the little less in others. "Compensation" does not apply to accumulative errors. If your micrometer is inaccurate all the measures made by it will be defective in the same ratio. When, however, the extent of the error of any measuring instrument is manifest the quantities need not be remeasured for statistical treatment. An allowance can be made in the final figures.

What are now classed as social or Government statistics were formerly called descriptive statistics derived by observation either of a whole population or deduced from a number of samples. The other kind of statistics, based on the study of the laws of chance, were known as arithmetical. We now measure the fact against the theory, and if they display a reasonable similarity, and if they vary in the same direction, the assumption is that some cause is at work, the influence or function of which can be at least estimated if not approximately determined. It is this tendency to change, or not to change, either to more or less that enables statistics to be used for measuring the whole from the part, or even to forecast the future movement or change.

PROBABILITIES.

When no facts at all are known there is "an equal distribution of ignorance." When a hundred or so horses are entered for a race many months before the race is run, a bookmaker may be ready to lay odds of fifty to one against any of them. As entries are scratched and some of the horses run in other races the odds shorten and bookmakers discriminate between one horse and another. Thus in all *a priori* speculation the introduction of a fresh cause affects the probability. The chance of a horse winning the Derby is different after winning or losing the Thousand Guineas. In the same way an underwriter quotes higher or lower premiums when he knows something about a ship and the risks to which it is exposed. The safety of a ship or any other structure exposed to risks is not measurable numerically. A constructional engineer designing a bridge uses a kind of statistical method, estimating the probable effects from what he knows of the strains and stresses to which the structure will be subjected. He is really calculating the probability of the new bridge behaving as other sample bridges have behaved. The engineer knows much more about his bridge than a backer knows about a horse, but he makes a much larger allowance for unknown influences. The engineer's factor of safety is not wholly in the nature of a statistical correction but an instance of the application of statistical methodology. Just as the statistician can use a table to test the probable correctness of an average derived from a greater or less number of samples, so the engineer uses his own formulæ. The best bridge builder is the one who can calculate all probable risks with the greatest exactitude. Engineering calculations do not impinge very much upon the abstract theory of probability, but the engineer uses a statistical method when fitting curves, often without realising the limits of accuracy (i.e., the probable error) of his deductions.

As an example of the application of the theory of probability to engineering, take the case of a bar which will just break under a load of $x+y$, this being the result of an "infinite" number of experiments with similar bars. The statistician would say that the bar is just safe with a load of x. The engineer, however, will measure the factor of safety from $x-y-\lambda$, where λ is the amount by which the lower probable error limit exceeds the worst observation. By this method the engineer can determine a *minimum* factor of safety.

The idea of significant figures is familiar to engineers who use slide rules. When significant figures suffice in a statistical calculation, care must be taken not to use illegitimate figures in the computation, or at least the illegitimate figures must not be retained in the final result. A rough-and-ready rule is that the result should not be written to more decimal places than are given in the least accurate component. For instance, if it is desired to arrive at the mean of such a series of approximate measurements as 321, 17·482, 68·243, 136·421, and 28·3, the addition,

TYPICAL SINGLE AND MULTIPLE SPINDLE HONING MACHINES

(For description see opposite page.)

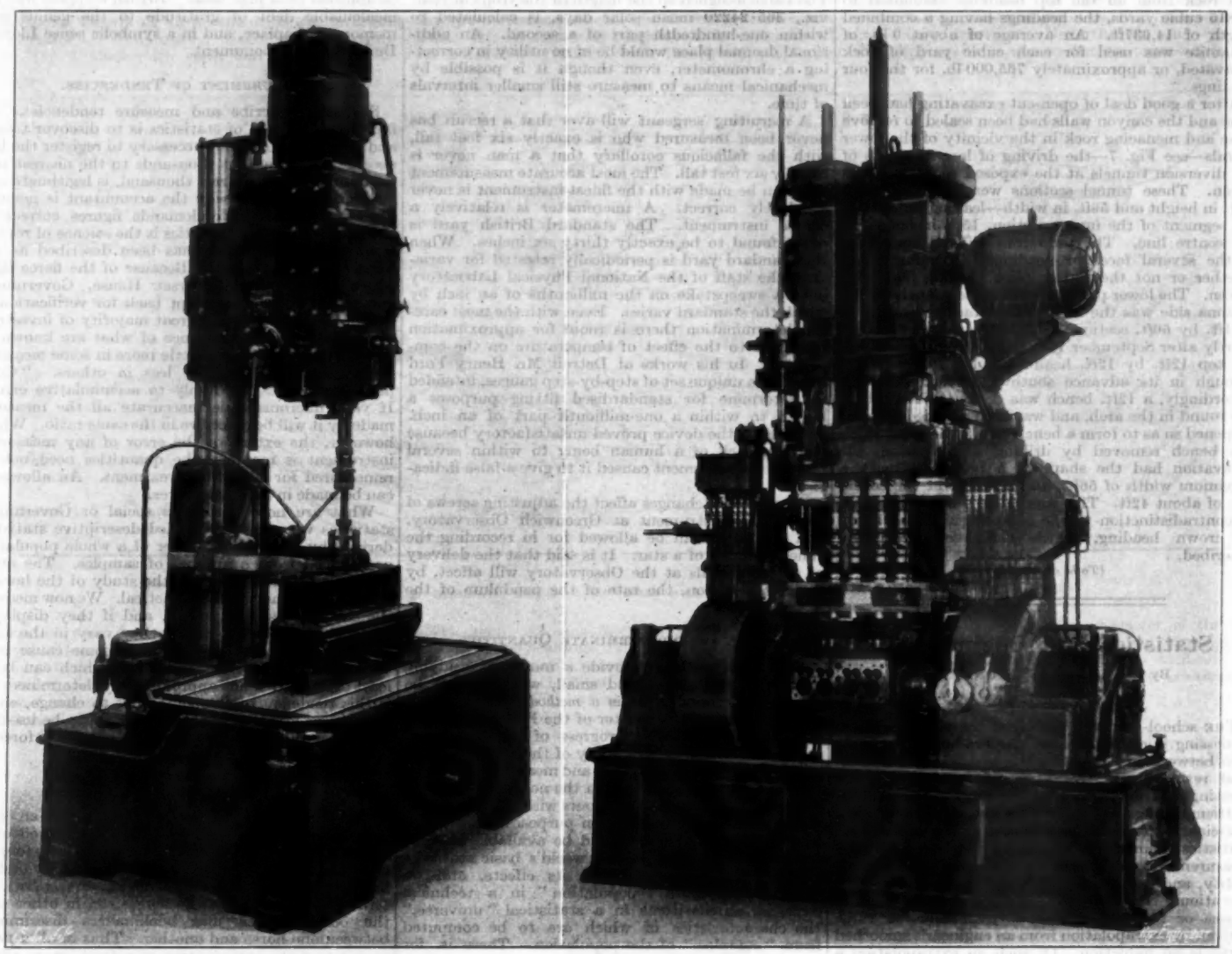

FIG. 82—KITCHEN AND WADE HONING MACHINE

FIG. 83—BARNES MULTI-SPINDLE HONER

based on the rounding-out process, is as follows :—

321	(*i.e.*, $321 \pm 0 \cdot 5$)
17·5	
68·2	
136·4	
28·3	
571·4	

The resulting mean ($571 \div 5$) can be rounded out to 114·3. As there is a possibility that the original measurements were not absolutely correct, owing either to the imperfections of the instrument or to the personal equation of the observer, the total might have been as large as 571·99 or as small as 570·90. The extended average might have been as large as 114·39 or as small as 114·18. Hence the computed result, 114·3, is a legitimate statistical compromise.

DEDUCTION AND INDUCTION.

It is not wholly superfluous here to note the difference between deductive and inductive reasoning. Deduction starts with an axiom, an experiment, or an observation (as in the sciences respectively of mathematics, chemistry, and astronomy), and determines by logical processes what will be the effect of a specified cause or antecedent. It starts with data or some item of knowledge. For instance, in all card-playing problems we know the constitution of the pack, and can deduce the probability of turning up an ace. With the inductive process we infer a cause from an effect. Here we can never be certain that we have inferred the correct cause out of all possible causes, unless having made the inference we test its validity by reversing the method. To justify induction to the point of certainty, we must show that the cause inferred must inevitably lead to the effect described. Even if this relationship is established we are still not quite sure that some other inference would not have had the same quality of inevitability. When Kepler inferred after plotting his observations that the planetary orbits were elliptical, it was no final proof that they were elliptical, but the inference was not disproved by further observations. Newton inferred a quadratic law relative to the resistance of moving bodies. When Colonel Duchemin, in 1842, applied the law to the observed behaviour of cannon balls, he found the formula did not account for all the ballistic phenomena, and he in turn inferred that there were two elements affecting resistance, one proportional to the square and the other proportional to the cube of the velocity. When Lieut. A. F. Zahm applied the Duchemin formula to the behaviour of the shapes of airships in the original Washington wind-channel, he evolved a still more refined exponential formula for skin-resistance. It was from Zahm's experiments that the stream-line was developed. When James Watt from his measurements of the behaviour of steam compiled his tables of pressure he was using the inductive method, and subsequent observations have not challenged his results. Kepler's result, however, led to the detection of a large number of residual motions, and to the discovery of new planets. These are all instances of the principle of probability applied to the investigation of causes. Such investigations have led to the systematic study of discrepancies, a method which has been so prolific in the realm of chemistry.

CONCRETE AND ABSTRACT.

The essential difference between deduction and induction leads to the mention of the essential difference between the concrete and the abstract. An engineering problem can only be solved on the concrete plane. There is a relation between the ideal and abstract heat engine of Carnot and the behaviour of a locomotive. Here, the engineer compares performance with perfection, just as the statistician compares an imperfect range of samples he is examining with the characteristics of an "infinite" universe which can be the subject of mathematical expression. Under the prompting of theory an engineer may smooth-out the curves of a dynamo's performance and may flatter himself he has achieved some approximation to an ideal dynamo. What he has done is to measure the difference of his observations against an abstract value. Such values, says the statistician, can never be known exactly, but only within limits.

Statistical data need to be collected, classified, tabulated, and computed. Collection is facilitated if the data are collected in a predetermined order, but usually some rearrangement is necessary. When obtaining data by means of a questionnaire it is prudent to put the most intriguing query first. If you ask the transport manager for a detailed report of vehicle performance, specifying a long list of information required, his impulse will be to put the request in a pigeon-hole. But if you start off by inquiring "Why do our Fords use so much petrol?" you set his mind in action. His efficiency is challenged. One part of a questionnaire should check another. For instance (*a*) How much oil do we purchase per month? (*b*) How much oil do we use per annum?

Uniformity should be aimed at when collecting quantitative data. Large and small measures must be referred to a common standard. For one series to be in tons and another in hundredweights (as in some Board of Trade returns of similar imports) leads to unnecessary calculation. If oil purchased is recorded in gallons, a stock record need not be returned to the nearest pint. Metric and British units must be converted if direct arithmetical comparisons are required, but if the quantities are being charted for comparison of trend, appropriate scales can be used on the chart without direct conversion. The tailor who accidentally measured his customer with the metric side of his tape did not need to convert the centimetres into inch equivalents. He just cut the cloth to the metric measurements.

Following the collection of data come classification and tabulation. The class included must exclude everything not of the same class. One would not put iron and copper together and call them metals, unless no other kind of metal were under consideration. The headings of the tables must define the classes. In subdividing things of the same class the subdivisions must be all inclusive. If the more important subclasses are selected for detailed analysis then there should be a column for "all others." When tabulating weekly figures they should not be assembled into calendar months without noting the different lengths of the months. Several methods have been tried to make monthly returns mutually comparable. One is to arrange for thirteen "months" of four weeks each in the year. Another is to take a standard month of, say, twenty-six working days and to add or subtract a day's average when there are not exactly twenty-six working days.

(To be continued).

Precision Grinding Machines.

No. XII.*

HONES AND HONING MACHINES.

THE ordinary internal cylindrical grinding machine suffers from a number of small defects so far as the generation of holes is concerned. Its accuracy falls away rapidly, for instance, when the bore is long in proportion to its diameter, and even if it is arranged to grind from either end of the hole a limit is reached beyond which the supporting arm of the machine cannot be made to hold the wheel rigidly enough against the work. There is no means of overcoming the difficulty if use is made of the ordinary grinding wheel smaller in diameter than the bore for, in these circumstances, the side pressure of the work upon the wheel must be met if the surface is to be satisfactorily ground. By honing, however, there seems to be no practical objection to grinding the whole length of a bore very greatly longer than its diameter, such as that of a gun barrel. A number of hones—usually six or four in all but the smallest sizes—are mounted on an expandible spider. Every stone presses with equal force upon the work, so that no side pressure is thrown on the shaft. Consequently, the only limitation on the length that can be ground is provided by the stiffness of the shaft, and it may be supported if desired in wheel-like steadies, the diameter of which is slightly smaller than that of the unfinished bore. Even on the short bores to be found in more general engineering work, such as the cylinders of motor car and aero engines, the hone has, to a certain extent, superseded the grinding wheel, not so much on account of any increase of accuracy, but because a better finish is obtainable at a less cost, and one which has better wearing qualities than that given by grinding, owing to the elimination of what, for lack of a better word, is sometimes known as "fuzz" and the elimination of high spots.

Hones may be driven by any drilling machine, providing sufficient power is available, but, since for the best results they should be reciprocated as well as rotated, it is better practice to use special machines. The rates of revolution and reciprocation depend upon the metal being honed and upon the diameter and length of the bore. According to the Barnes Drill Company, of Rochford, U.S.A., surface speeds of 200ft.–250ft. per minute are suitable for cast iron and brass, and of 150ft. to 200ft. per minute for steel, while the reciprocating feed for the first two metals should be about 50 lineal feet, and for steel 40 lineal feet per minute. The length of the stroke for any particular job is determined by the amount by which the hone is to overrun the bore. For the majority of jobs an overrun of an inch, or a little less, is plenty, and since the hone spider has a length considerably greater than this amount, the length of stroke is nearly always less than that of the bore. For instance, a stroke of 7in. would be required to hone a cylinder 9in. long if the stones were 4in. in length and there was a 1in. overrun at each end. Honing allowances, of course, vary with the size of the cylinder in question; practice favours up to 0·003in. below 6in. in diameter, rising to 0·008in. for 12in. cylinders upwards. The output of a hone is likely to be greater than that of an internal grinding machine, owing to the fact that the length of the stones can be considerably greater than the width of a grinding wheel, while, at the same time, more than one point of contact with the work is obtained. Another factor that influences production possibilities in favour of the hone is the fact that to a certain extent it is self-centering, so that extreme care in setting up the work is not necessary. In addition, compared to a "planetary" type grinder, the honing machine is very simple, as may be seen by reference to the engraving Fig. 82 at the top of the previous page.

TYPICAL HONING MACHINES.

The machine illustrated is made by Kitchen and Wade, Ltd., of Halifax, and is capable of honing bores from 1in. up to 6in. in diameter, with a maximum length of 18in. It has three spindle speeds from 180 to 320 r.p.m. inclusive, and three rates of reciprocation or cycles ranging from 90 to 50 per minute. The length of stroke may be varied between 0in. and 11in. In addition, the same motion may be performed by hand in order to obtain a particularly high finish. The machine is driven by a vertical spindle motor mounted on top of the head through nickel-chrome, heat-treated steel gears running in ball bearings. All the gearing for both spindle speed changes and for the length and rate of reciprocation is enclosed within the head which is mounted on a stout column, and may be raised or lowered by the use of a star handle setting screw gearing in motion. The splined spindle is hollow and is provided with a quick-action chuck, so that the hones may be rapidly changed when necessary. To reduce the time required for setting-up, adjustable clamps are fitted to slides machined in the lower part of the column. A reservoir is provided in the lower part of the bed at the back of the machine, from which the paraffin lubricant is drawn by a motor-driven pump, while toe slots are cut in the bottom of the front of the bed to facilitate inspection of the work by the operator.

For high productivity such machines can be made with several simultaneously operating spindles, and are much used for finishing the bores of motor car cylinders in America at least, if not in this country.

Such a machine, made by the Barnes Drill Company, of Rochford, Illinois, America, for which Burton, Griffiths and Co., Ltd., are agents in this country is shown by the next engraving—Fig. 83. The reciprocating motion of the four hone spindles is operated hydraulically from two rams. Many of the machines made by this company are equipped with a single lever controlling the driving clutch and the hydraulic system in such a way that either may operate separately. The collapsed hone may be entered into the cylinders without rotation, or be withdrawn in the same state. Stops are provided for the reciprocating motion so that the exact required overrun may be attained. The machine shown is particularly adapted for honing the bores of motor car engine cylinders, arranged as a V with four cylinders in each block. The work-holding fixture, which is operated hydraulically, indexes round when work on one bank of cylinders is concluded ready for the honing of the other block. Owing to the fact that the cylinders in one bank are offset, a lateral movement is also required. In order that it shall be as productive as possible, automatic expanding hones are used, and the machine has an automatic stroke-counting device.

The construction of the spiders which support the hone stones is perhaps a matter of more interest than the actual honing machines themselves, many of which are made very much in accordance with good drilling machine practice, with a smaller range of speeds and a reciprocating motion substituted for the feed. Indeed, as we mentioned above, any good drilling machine may be used for honing if required. All honing spiders are so constructed that they may be expanded progressively to suit the diameter of the hole as the grinding takes place. The spider made by the Hall Manufacturing Company, of Toledo, U.S.A., is illustrated by the line engraving Fig. 84. Within

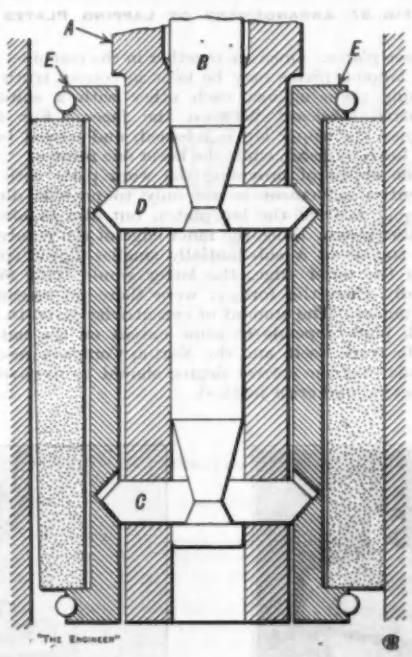

FIG. 84—CONSTRUCTION OF HONE SPIDER

a hollow spindle A a shaft B having two tapers cut upon it opposite the top and bottom of the hones respectively can be moved longitudinally. The cones engage with pins C and D tapered at each end and supported by transverse holes in the spindle, and force them outwards into tapered sockets in the stone carriers E. The distance between the two sockets on any carrier is so arranged that when the spider is collapsed the outer tapers of the double-ended pins bear against one side of the socket only and tend to move the carrier in opposite directions. As the expanding mechanism is operated by forcing down the central shaft the pins are forced outwards into the sockets, so expanding the spider till the hones are cutting all round. By this arrangement, it is claimed, compensation for any uneven stone wear exists. One of the stones in the engraving is shown to be exaggeratedly tapered. When this occurs it is claimed that as a result of the expanding action the stone carrier will, as it were, rock about the upper pin D until the whole face of the stone makes contact with the work. On the upper part of the spindle a handle is provided, which when raised lowers a bush and allows the central shaft B to be forced downwards against the pins by a strong spring. Below the handle a thumbscrew micrometer ring allows the expanded diameter of the hone—and hence the finished diameter of the work—to be predetermined by setting a limit to the travel of the bush.

LAPPING MACHINES.

Honing is a process which, although it gives a better finish than grinding, is no more accurate. The process of lapping, however, provides not only a finer finish, but also a greater degree of perfection than any other known method of machining. It has been used for centuries where absolute accuracy has been required, but only latterly has it been made possible in a machine. Until comparatively few years ago the process was only used in the production of gauges, the grinding-in of motor car valves and similar operations, in which the need for great perfection outweighed all considerations of cost. When performed by hand it is a slow and tedious operation, requiring for many parts the exhibition of a high degree of skill on the part of the operator, so that no surprise need be felt that it was used as infrequently as possible. Its principle is, very simply, that of introducing between two plates of metal grains of abrasive of a diameter of not more than 0·002in. and preferably very much less, held in suspension in lard oil, machine oil, paraffin, or turpentine. Rubbing the two surfaces together then has a slow cutting action, which produces a very fine microscopically flat surface. In commercial lapping the part to be finished, which generally has a lapping allowance not much greater than 0·0002in., is usually placed between two plates of some softer material. Copper, mild steel, or cast iron may be used. In general the softer the material of the lap the more rapid is the cutting action, owing to the fact that the grains of abrasive become embedded in it. The nature of the grain also has its effect upon the rate of production. Preferably it should be round, solid, and capable of maintaining its shape, since although if it continually breaks down and presents new cutting edges, it will cut very fast it will leave on the work scratches which are difficult to eliminate. Hand lapping, which is a very slow operation and in which the general tendency is to overcharge the work, lies hardly within the scope of these articles. Within recent years, however, the mechanical lapping machine has been much developed. In contrast to hand lapping the general tendency with machines is to run them too fast. The Norton Company, of America, recommends the very moderate speeds of 15 to 25 surface feet per minute with soft laps for "roughing" work and 20 to 30 surface feet per minute when hard laps are used for finishing.

AN ENGLISH MACHINE.

A lapping machine made by B.S.A. Tools, Ltd., of Birmingham, is illustrated in Fig. 85. An upper and a lower lap, both made of cast iron, are used and the

FIG. 85—B.S.A. LAPPING MACHINE

work is loosely held by a cage or work plate, which is suspended between them and has an excentric motion with regard to them. In the design of such machines care must be taken that the position of the work relative to the laps, together with the amount of excentricity, is such that every portion of the laps is brought into action to an equal amount. The lap plates must also be kept level. As an aid to maintaining these requirements the upper lap plate is allowed to have a certain amount of "float," so that it may be self-aligning with the lower plate. Where a very high finish is not required the plates themselves can be made of or coated with abrasive material, but when the best possible surface is wanted an abrasive mixture is pumped between the plates from a central point and fed to all parts by centrifugal action, which gives a very even distribution.

The makers recommend lapping allowances of 0·0002in. to 0·0004in. for cylindrical work and of 0·0003in. to 0·0005in. for flat work. Any large deviation from these limits, it is pointed out, is likely to set up undue wear of the lap plates. Though such wear can be corrected as a rule by revolving the lap in contact with an oil-loaded oil stone, re-grinding may also be necessary if the wear is allowed to become

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pronounced. For the best finish a lapping solution composed of 2 lb. of grade 100 Abradum powder mixed with 2 gallons of paraffin and 2 gallons of light hydrocarbon machine oil is recommended, while a quicker cutting compound can be made by adding further 1 oz. of triple-washed emery.

The B.S.A. machine is capable of lapping both cylindrical and flat work, the only alteration necessary to change from one to the other being the substitution of a different work plate. Where flat work is to be dealt with the work plate, which is slightly less thick than the parts themselves, has apertures roughly the shape of the part cut in it. The position of the work pieces in conjunction with the excentric motion of the plate must be such that the whole of both lap surfaces is covered. Round pieces with a central hole may be mounted on a work plate provided with a number of spokes slightly less in diameter than the holes in the work; it is usually advantageous to arrange the spokes on lines tangent to a circle of about 3¼in. diameter around the centre of the plate rather than radially. A work plate for holding motor car valves

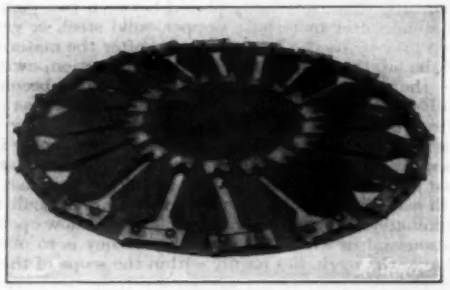


FIG. 86—WORK PLATE FOR MOTOR CAR VALVES

is shown in Fig. 86. Only the stems are lapped, the heads projecting beyond the edges of the laps.

An excentric movement is given to the work plate by means of two arms connected to excentric spindles mounted one on either side of the machine outside the pan. The amount of excentricity is variable and should, when the machine is in operation, be as low as is compatible with proper covering of the lap plates. The machine illustrated, Fig. 85, is belt driven and the upper lap is shown raised for inspection of the work. The abrasive is supplied by a small pump and flexible hose to a point within the upper lap, whence it flows outwards and is collected by the pan and returned to the sump. The line engraving Fig. 87 shows how the pan is suitably shaped to prevent the abrasive reaching the lower bearings.

There appears to be a rather surprisingly large difference between the wear-resisting properties of machine and hand-lapped productions. In an article that appeared in the *American Machinist* some years ago the figures obtained by a motor car manufacturer as to the wear of plug gauges were given. We reproduce them in the following tables.

After plugging 6000 holes the following wear was detected :—

	Hand lapped gauge, in.	Mechanically lapped gauge, in.
End	0·00065	0·0002
Centre	0·00028	0·00002
Back	0·00012	0·00000

No more holes were plugged with the hand-lapped gauge, but after 20,200 holes the mechanically lapped gauge showed wear as follows :—

	In.
End	0·00045
Centre	0·00017
Back	0·00015

The real secret of successful machine lapping lies in the correct facing of the lap surfaces, and it is essential that they should be kept in good condition. According to the Norton Company, of America, three lap plates, after planing, should first be hand scraped to a good surface plate and then worked together on an upright drill press, one lap plate being fastened to the table and the other rested upon it. The surfaces are coated with a film of abrasive and oil. The upper lap is caused to move in a circular excentric path across the lower and in consequence the former rotates slowly about its axis. The faces of the two laps are thus made to match each other, but to obtain a true plane surface, the first lap must be worked with the second, then with the third, and the second with the third, and the third with the first, on the identical principle that is employed in the scraping up of master

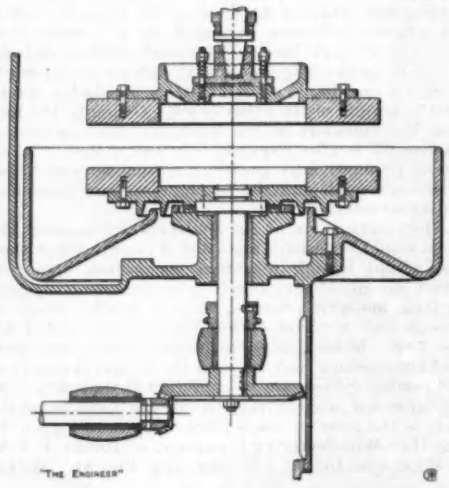


FIG. 87—ARRANGEMENT OF LAPPING PLATES

surface plates. Once set together in the machine, the two lapping plates may be kept in correct truth by lapping them against each other with a suitable abrasive lubricant between the faces. For this purpose the upper lap is released, and moved back and forth by hand, while the lower one rotates.

The object of providing the work plate with an excentric movement is not only to prevent direct unequal wear of the lap plates, but also to obtain parallel parts. Since the inner edge of the revolving lap travels at a substantially smaller lineal speed than the outer edge, the latter would wear more rapidly than the former, were there no excentric movement. The amount of excentricity given to the work plate depends to some extent on the nature of the work itself, and the Norton Company recommends that the correct degree should be discovered by a trial and error method.

A small machine made by the company just mentioned is illustrated in Fig. 88. It is capable of dealing with either cylindrical or flat work, and is intended for use in the tool room where extreme accuracy is required. Cylindrical pieces, 1½in. in diameter, and up to 3in. long, or flat pieces 1½in. thick of the same length, may be accommodated so that the machine can lap plug gauges, size blocks, or such production parts as rolls for roller bearings and the sides of small ball bearing races. The machine consists of a base within which is placed the 1 H.P. motor driving the lower lap through a silent chain and a worm and worm wheel mechanism running in an oil bath. Supported by a column erected at the back of the base there is an arm carrying the upper lap, which does not rotate, but is supported sufficiently freely to take up any slight lack of parallelism between itself and the lower plate, and may be raised or lowered by means of a hand wheel. Two methods of driving the work plate are available according to whether the work is cylindrical or flat. Within the hollow driving shaft of the lower lap there is another driven in the same direction, but at a slightly slower speed. On the head of the latter there is mounted an adjustable excentric pin, around which the work plate may rotate and by which it is given a motion

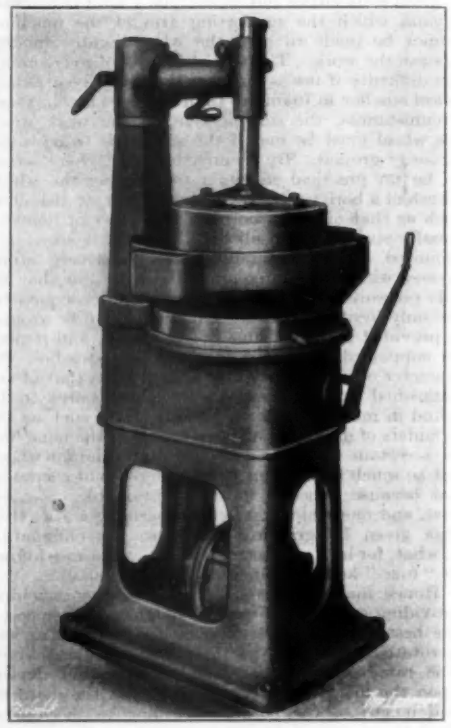
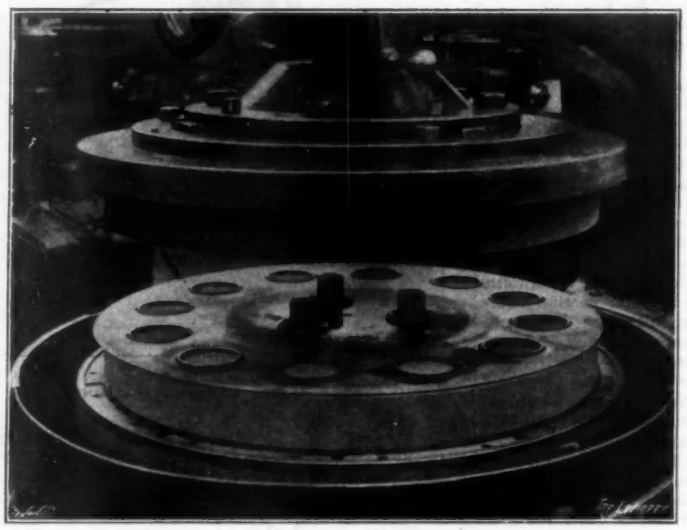
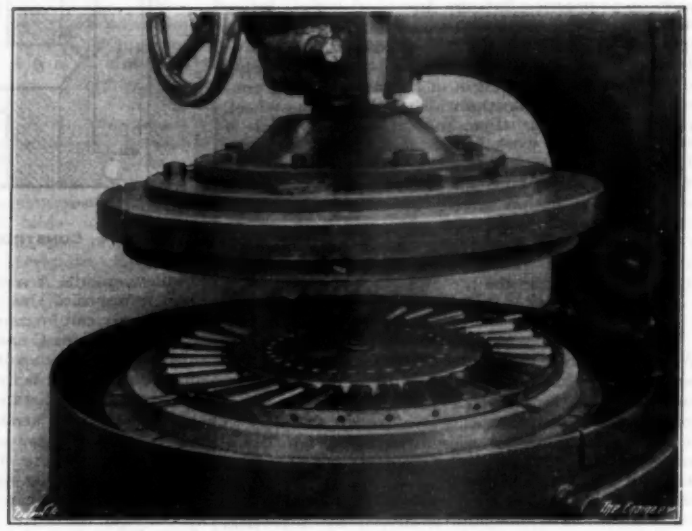


FIG. 88—SMALL NORTON LAPPING MACHINE

excentric with that of the laps. The same arrangement is not suitable for both round and flat work. The motion just described is made use of when cylindrical work is to be lapped; for flat work, however, a more complex movement is desirable. For this purpose the rotation of the central work plate driving spindle is stopped, and two planetary gear wheels engage with teeth cut on its shaft and with internal teeth on the plate carrying the lower lap. The gear wheels thus trace out a planetary path around the central spindle and also revolve. Pins may be screwed into holes in the bosses of the planetary gear wheels bored at differing excentricities, and the work plate is then mounted upon these pins and is consequently given a compound excentric rotation with respect to the laps, which may be altered at will to suit various conditions. In use the parts to be lapped on this machine are coated with a thin layer of the abrasive; it is not found necessary to introduce the abrasive as a continuous stream.

Typical work holders for flat and cylindrical work, the latter with a bore sufficiently large to allow the use of a "spider" mounting, are shown in the two engravings, Figs. 89 and 90. The machine illustrated is of a larger type than that just described, and instead of utilising an abrasive solution the laps themselves are made of abrasive wheels. For flat





FIGS. 89 AND 90—TYPICAL WORK HOLDERS ON A NORTON LAPPING MACHINE

work, such as the rings shown, three work plate driving pins are used, mounted on the planetary gear already described. Machines utilising abrasive laps are much more rapid in operation than those using abrasive solutions but the finish and accuracy are not so perfect. They both greatly exceed those of the grinding machine, however.

(To be continued.)

Modern Hydraulic Operation of Machine Tools.*

By H. C. TOWN, A.M.I. Mech. E.

(Continued from page 569.)

APPLICATIONS TO THE VARIOUS TYPES OF MACHINE TOOLS.

(1) *Broaching Machines.*—This type of machine tool was probably the first to which hydraulic transmission was applied, the application not constituting a revolutionary step in itself, as broaching had been done in many cases on ordinary hydraulic presses which bear a close resemblance to the broaching machine. The difference in the machine tool application, however, is that no power is wasted, as the pressure of the oil and power absorbed is only that of the resistance being overcome. In ordinary hydraulic installations with accumulators in circuit the maximum power is used at all times, irrespective of whether it is required. Due to this drawback, the design of broaching machines in which the broach is pulled through the work by a screw was developed. The first attempts to introduce hydraulic transmission in place of this arrangement showed a distant jump as the teeth were pulled through the work, and were condemned for lack of steadiness. To-day it is proved that the hydraulic broaching machine is capable of pulling a broaching tool from three to five times as fast as the screw type machine, and that the broach lasts much longer. Further, considerably less power is required to perform a given operation on the hydraulic type than on the screw type. Again, the efficiency of the hydraulic machine may reach 88 per cent., compared with 23 to 45 per cent. for the screw machine. Assuming that on a broaching machine a pull of 12 tons is required, then the net effective area of the piston for the cutting stroke would be 12 square inches if the maximum permissible pressure on the oil was 1 ton per square inch. If the cutting speed was 25ft. per minute then the pump capacity would be $25 \times 12 \times 12 = 3600$ cubic inches per minute. On the return stroke the only resistance to overcome is frictional, so that the effective piston area can be greatly reduced. Assume this to be 3 square inches. The return speed of the broach would be $25 \times 4 = 100$ft. per minute if the amount of oil delivered in both directions was the same. The force available for the return stroke would be 3 tons. It will be seen that four times the quantity of oil must leave the cutting side of the cylinder compared with the opposite end, so that by-pass valves are generally fitted to allow the difference to pass into a tank. This oil may be drawn from the tank by the pump, and the remainder from the return side of the cylinder. The stroke mechanism of a variable-delivery pump can be operated by tappet rods to stop the broach movement or effect automatic reversal. It has been stated that by means of a pressure gauge fitted to hydraulic machine tools the action or condition of a cutting tool could be checked. This is of especial value on machines of the type under survey using expensive cutting tools, for guesswork on the part of the operator as to when to change a broach is replaced by exact knowledge obtained by reference to the gauge. Supplementing this, a relief or safety valve, which is analogous to a slipping clutch on a mechanically operated machine, is fitted. With the valve arranged to blow at the maximum feeding force required the possibility of damage to the machine through overload, inattention of the operator, or to some obstruction left on the slides, is prevented.

(2) *Grinding Machines.*—Following the successful application of hydraulic transmission to broaching machines, hydraulic equipment of grinding machines rapidly followed, until at the present time more advantage is being taken of hydraulic developments on this class of tool than on any other. This may be accounted for by the advantages of quiet smooth operation and reversal without shock so necessary on a precision tool. Further, while variable-delivery pumps are used, as the feeding rate is practically constant at all times, gear pumps can be successfully used, with a saving in cost. From the previous description of the oil circuit when using a constant-delivery, constant-pressure gear pump, it will be seen that if the load to be overcome causes a pressure in the cylinder of 200 lb. per square inch, using a gear pump giving a constant pressure of 250 lb. per square inch, would give a difference in pressure of 50 lb. per square inch on each side of the throttle valve. Alternatively, a pressure of 50 lb. per square inch in the cylinder would give a difference of 200 lb. per square inch on each side of the throttle valve, so that equal feeding rates would not take place with the same valve setting. On grinding machines, however, assuming a table to weigh 20 cwt. and requiring 200 lb. per square inch pressure to overcome friction, the additional force for the cut may not exceed, say, 20 lb. per square inch. Thus with a small variation of pressure from 200 lb. to 220 lb. per square inch no difficulties arise with valve gear, and while the maximum power is being used at all times due to the pump forcing the surplus oil past the relief valve, this power is generally not more than 1 to 2 H.P. Further, this surplus oil can be used for operating auxiliary equipment, such as chucking fixtures and diamond dressing tools. Reversing valves are a necessity with this system, and rapid power motions can be obtained by allowing the full oil delivery to enter the cylinder as a result of short-circuiting the throttle valve. This requires a comparatively large pump with a fair quantity of oil passing through the relief valve during ordinary feeding, and a large oil tank to prevent overheating of the transmission fluid. In the design of grinding machines using variable-delivery pumps it is necessary to consider the vibration or resonance in the pressure oil resulting from the rapid succession of impulses of the pump plungers, the intensity of these impulses varying with the existing pressure. For this reason low-pressure units should be used for grinding machines to avoid high-frequency vibrations.

(3) *Drilling and Boring Machines.*—To have complete individual control of two or more hydraulic cylinders, each cylinder must be driven by its own pump, and the entire flow must go through that cylinder. However, drilling machines having several feed cylinders operated simultaneously by oil supplied by a single gear pump have proved successful. If sufficient oil is pumped at all times, so that under the worst condition of usage there is still a slight amount being by-passed through the relief valve, the rate of movement of the piston at any one cylinder can be changed without any material change in the rate of travel of the pistons in the other cylinders.

If the volume of oil is not sufficient to maintain the pressure adjusted by the by-pass valve in the case of two or more cylinders operated in parallel, the cylinder encountering the least resistance may take the entire flow until its stroke is finished. The remaining units will operate successively according to the order of their resistance values.

Cylinders Operated in Series.—If the speed control required on two cylinders is simultaneous and proportional, the two cylinders may be placed in series in a closed circuit with a single pump. Such a circuit with three cylinders in series is shown diagrammatically in Fig. 15. The three cylinders must be graduated to the requirements of the heads. If one head is to move twice as fast as another, its cylinder must have half the volume. Also each cylinder must be so designed that the volume displaced in its piston-rod end is equal to the volume displaced in the head end of the next succeeding cylinder. This is evident from the diagram, as the oil supplied to the head end of each cylinder after the first one, comes from the rod end of the preceding cylinder. In order to keep the movement of such a set of pistons properly co-ordinated, the pistons must be run against their cylinder heads at the termination of each cycle, so that they always start the next cycle in the same relation. The relief valves at A, B, and C permit oil to pass around any piston that has already stalled against its cylinder head during the back stroke, thus bringing all the pistons successively back against their cylinder heads. This series divides the total working pressure into as many parts as there are cylinders. This reduces the maximum working pressure available in each cylinder and tends towards large cylinder diameters. It is therefore sometimes better to use a multiple transmitter, consisting of one double-acting cylinder reciprocated by the pump and operating several cylinders, whose piston-rods are attached to a single crosshead. Each of these secondary cylinders acts as a pump or impeller for its own individual driven or feeding cylinder. This system establishes several separate closed hydraulic circuits, each of which operates its feeding cylinder at definite speeds, the pressure in each separate circuit depending on the resistance against the piston-rods of the respective feeding cylinders and on the corresponding piston areas.

The strokes of all the impelling cylinders are the same, but their diameters and the diameter of the feeding cylinders may be varied to give any desired feeding forces and strokes to the respective feeding cylinders, providing the totals are within the power capacity of the pump. All speed variations and distances travelled by the pistons of the respective feeding cylinders are proportional to the speeds and distances travelled by the piston of the main cylinder connected to the pump. In this case also it is necessary to provide means similar to those shown in the series circuit for bringing each of the feeding cylinders against this cylinder head at the end of every cycle in order to keep the pistons in co-ordination. In practice, both circuits require low-pressure make-up lines from the pump to each circuit.

One of the most satisfactory arrangements for drilling and boring machines consists in a combination of a small-capacity variable-delivery pump, working at high pressures for feeding purposes and a large-capacity gear pump working at a small pressure for rapid traverses. This method is often more economical than employing a large variable-delivery pump, particularly where the cutting forces to be overcome are large relatively to the frictional loads to be overcome in moving the slides. Further, one of the difficulties of employing gear pumps on drilling machines is eliminated, *i.e.*, the case of different pressures occurring on each side of the throttle valve, so that when the drills break through the work, there is a sudden jump forward due to the rapidly reduced pressure in the feed cylinder.

The cycle of operations required generally consists of rapid approach of the drills, feed forward for cutting, rapid return, and either stop or the commencement of a new cycle, these sequences being obtained by stops on the slides operating suitable valve gear.

(4) *Lathes.*—The problem of applying hydraulic transmission to lathes of the standard type is less easy of solution than in the case of the machine tools previously described, and its use for feeding purposes is at present restricted to lathes of the short traverse non-screw-cutting type, known generally as the rapid-production multi-tool type.

This is scarcely surprising when the difficulties of incorporating separate cylinders and pistons for sliding and surfacing motions, together with a screw-cutting mechanism, are reviewed. The designer has the alternative of placing the cylinder for the sliding motion in front of the bed in place of the usual feed shaft, or down the centre of the bed. In one of the same longitudinal or vertical positions the feed cylinder for surfacing must also be fixed, for it is virtually impossible to place this in a transverse position in place of the surfacing saddle screw, owing to very restricted space, unless it is overhung in an inconvenient and unsightly position at the back of the saddle. For this reason final connection between surfacing slides is generally by link or gear motion from the piston-rod and not direct.

In the event of fixing the cylinder positions along the bed front, the difficulty of locating the lead screw in the most suitable position, *i.e.*, in a most protected position close to the slide, arises, or, alternatively, the centre bed position of the cylinder may mitigate any advantage in the screw being so placed. For while the location of a saddle sliding on a bed designed on the narrow guide principle is ideal if the screw is placed close to the front guide, it is liable to produce cross-winding when the saddle is pulled by the piston-rod from the centre of the bed. These difficulties are, of course, accentuated in the case of a lathe with a bed longer than standard, a point being soon reached where considerations of strength and rigidity, and the fact that the length required for the piston-rod is approximately that of the saddle traverse, renders the arrangement out of the question. True it is, that the alternative of hydraulic motors coupled to the usual mechanical elements could be used, but the cost on lathes would be prohibitive for the following reasons.

Of late years the tendency in lathe design has been to incorporate a change-feed box of the magazine type, giving any one of thirty different speeds or upwards. This has been not so much for the purpose of providing a large range of feeds, but for time-saving and general convenience in screw-cutting. The cost of these somewhat elaborate gear-boxes has been partly offset by the saving of the usual set of loose change wheels, but if, in addition to this cost is added the extra equipment for hydraulic transmission, the building of the machine becomes an expensive proposition. The question next presents itself, What are the possibilities of dispensing with the feed gear-box altogether and using a hydraulic pump for feeding and screw-cutting? Unfortunately for this purpose, while oil is considered to be incompressible, practical experience proves otherwise. Assuming that all leakage is prevented, under pressure oil acts as a spring, and from investigations of Hyde, published in 1920, the bulk modulus of compressibility of oil at 40 deg. Cent., and pressures of from 1 to 5 tons per square inch, ranges from 242,000 to 315,000, being roughly equivalent to a coefficient of 0·35 per cent. for every 1000 lb. per square inch pressure. Experience with hydraulic presses also shows that great pressures of several hundred tons are developed

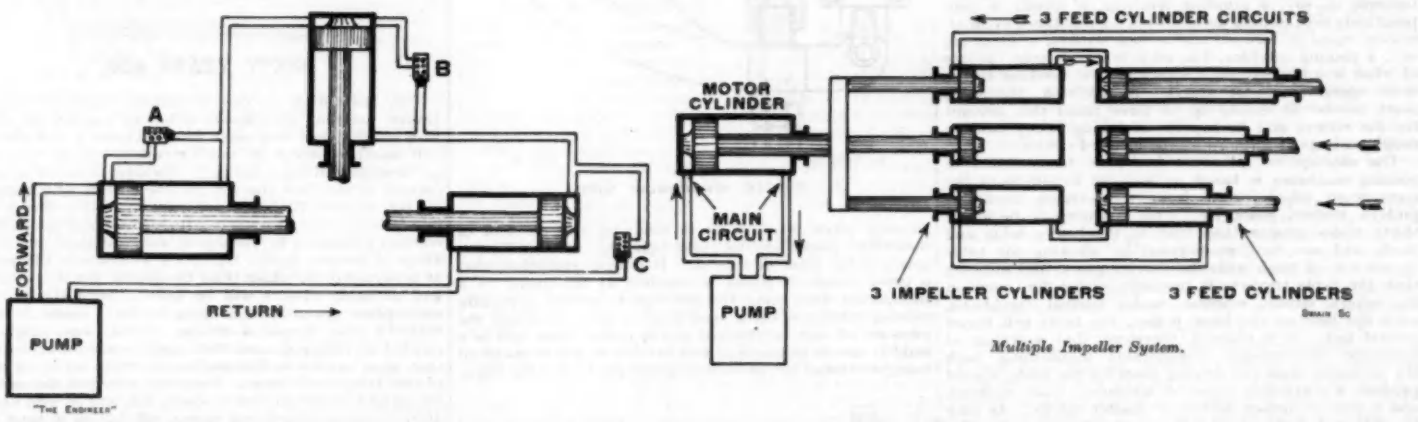


FIG. 15—CYLINDERS OPERATED BY SERIES CIRCUIT

* The Institution of Mechanical Engineers.—Abstract.

without appreciable ram movement, so that actually it would seem that the movement of a slide and the hydraulic pressure are not definitely correlative.

The serious effect of slip through leakage must also be taken into account, and from investigations using a feed cylinder of 3¼in. bore, and a pump capable of giving a maximum feeding force of 1000 lb. per square inch, or a total pressure of 11,000 lb. to the cutting tool, the slip amounted to 13 cubic inches of oil per minute. A reduction of the pressure to 250 lb. per square inch brought down the slip to 4 cubic inches per minute. In the event, then, of a traverse being set for 6in. per minute, with a normal pressure of 250 lb. per square inch, and through increased duty the pressure rising to the maximum of 1000 lb. per square inch, causing a slip of 9 cubic inches of oil, the rate of feed would be reduced to almost 5¼in. during this period, a reduction of 14 per cent. The amount of leakage is practically constant for a given pressure, so that increasing the feed to, say, 18in. per minute would give a reduction of 4·5 per cent. Leakage takes place past the piston and the distributing valves, and while the figures given could be reduced by special precautions to, say, 1 per cent., it is more than doubtful if sufficient accuracy could be maintained for even commercial screw cutting.

(5) *Milling Machines.*—The special requirements of milling machines render the application of hydraulic equipment somewhat more difficult than in the case of, say, drilling or grinding machines, and even after very lengthy experiments the number of hydraulic milling machines in use is very limited.

The conditions differ from those of other machine tools in that the cutter sometimes has the effect of dragging the table in advance of the feed. This is well known to be the case when the cutter is rotating against the work in the same direction as the feed, and can be overcome in a mechanical feed by eliminating backlash between the feed screw and nut. On a milling machine, with hydraulic transmission, the pressure is made up of the hydraulic pressure, plus or minus the cutting pressure transmitted to the piston-rod, according to the direction of cutter rotation, and it is essential, therefore, if the motion is to be uniform, that the pressure urging the piston forward should be constant.

(6) *Planing Machines.*—In the field of reciprocating machine tools, mechanical transmission is making a more determined opposition against the inroads of hydraulic power than in the case of rotary machine tools.

This is not surprising when it is realised that the table traverse of, say, a grinding machine, is merely a comparatively slow feeding motion with the resistance approximately equal on forward and reverse strokes, whereas on, say, a planing machine, the table traverse must operate at what is equivalent on a rotary motion machine to the work speed or cutter speed. In addition, the table must reverse at speeds up to three times this amount for the return, and be capable of taking heavy cuts on rough castings or forgings on the forward stroke.

The attempt to introduce hydraulic transmission to planing machines is based on a desire to eliminate the momentum which arises from the driving members, pulleys, motors, gears, &c. This is known to be about thirty times greater than that of the heavy table and work, and can be demonstrated by allowing the table to run out of mesh with the driving gears, and noticing that the table traverse is probably under 2in. even on the return stroke, whereas, under normal conditions, with the belt on the loose pulley, the table will travel several feet. It is claimed, therefore, that a system of hydraulic transmission, considerably diminishing both the reversing mass and driving gears for the table, should produce a maximum degree of efficiency, quiet running, and a planed surface devoid of chatter marks. As may be anticipated, the initial success in this direction lies with the short-stroke machines of the shaper, or planer-shaper type.

Referring first to planing machines, the chief difficulty of hydraulic transmission arises from the high table speeds required, both on the cutting stroke as a result of the modern requirements in regard to tungsten-carbide tools, and on the return the desire for time saving. To effect this cycle by oil pressure, using a single cylinder and piston in the conventional way, would probably lead to failure due to the enormous stresses set up in the pipe lines at the point of reversal, and the tendency appears to be to use two or more cylinders. Even so, the difficulties of utilising cylinders increase greatly with the length of the machine; the longer the line, the larger the cylinder. Problems also occur in regard to friction and flow of oil through the cylinders, and a consideration of the pressure oil quality shows that it is governed by the necessity of minimising both slippage and hydraulic friction, the slippage requirements demanding a relatively high viscosity, while to reduce hydraulic friction a low viscosity is necessary. In addition, the pressure oil should also be suitable for lubrication.

Fluids in motion are subjected to certain resistances which are assumed to be due to friction. Actually, these resistances are mainly due to viscosity—that is, to the resistance to sliding between two adjacent layers of the fluid. Viscous resistance is a shear resistance, and is probably due to the tension between the particles on a plane inclined to the plane of shear. The resistance would then be equal to the components of this tension, in the plane of shear. It has been suggested that the resistance of a fluid to tension is due to molecular attraction, in which case the apparent frictional resistance is primarily due to this cause. It has been found that the motion of a fluid is a steady streamline flow for low velocities only. After a certain velocity is reached the motion is no longer steady and eddy currents appear. The velocity at which the flow changes from steady to eddy flow is known as the critical velocity.

For liquids moving with a steady streamline motion, the frictional resistance obeys certain laws, but once the critical velocity is passed, there is a distinct change in many of these laws.

For steady streamline flow the frictional resistance is:

(1) Proportional to the velocity.
(2) Independent of the pressure.
(3) Proportional to the area of surfaces in contact.
(4) Independent of the nature of the surfaces in contact, and
(5) Varying greatly with the temperature.

On account of (4), it is inferred that when a liquid is flowing past a surface with a velocity less than the critical velocity, a film of stationary liquid is formed over the surface; the resistance is then due to viscosity only.

For turbulent flow beyond the critical velocity, this being the case in the machine under consideration, the frictional resistance is:

(1) Proportional to the square of the velocity.
(2) Independent of the pressure.
(3) Proportional to the density of the fluid.
(4) Varying only slightly with the temperature.
(5) Proportional to the area of surface in contact, and
(6) Depending on the nature of the surfaces in contact.

A consideration of the investigations of the flow of oil

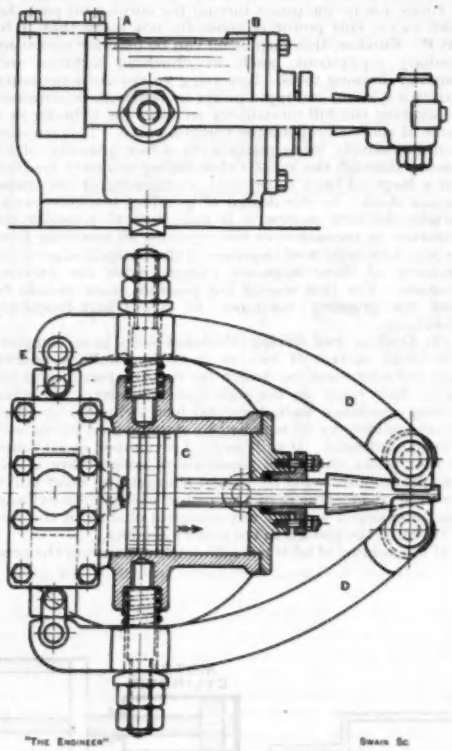


FIG. 16—HYDRAULIC VICE

through pipes is of value in studying the problem of hydraulic planer drives, although the main difficulty arises at the point of reversal. It is well established that a great excess of power is required at this point on a mechanical drive, and the attempt to reverse a rapidly moving column of oil is analogous to this. Although the pressure oil may be checked at the pump, there will be a sudden rise in pressure of this oil due to the momentum being destroyed by the counter-pressure of oil at the opposite side of the piston. This tends to cause a pressure wave to be transmitted along the cylinder, which may set up serious vibrations. The magnitude of this pressure will depend on the speed of the reversal and on the length of the pipe. This sudden rise in the pressure is known as the hammer blow and the magnitude of the pressure wave can be found from $p = \frac{w l v}{g t}$ lb. per square inch, where l is the length in feet, v the velocity in feet per second, and t the time in seconds in which the liquid is brought to rest. This is the simple theory only; actually, the liquid would compress on account of its bulk elastic modulus, and the pipe would expand laterally on account of its modulus of elasticity. These would both slightly affect the problem, but, neglecting minor points, sufficient has been indicated to explain the defects on some hydraulic planers, namely, sluggish reversal and jerky traverse. Another feature tending to create difficulties is the fact that there is a limit to the suction oil speed, approximately 20ft. per second, beyond which the suction oil will not follow up the circuit, thereby tending to create a vacuum.

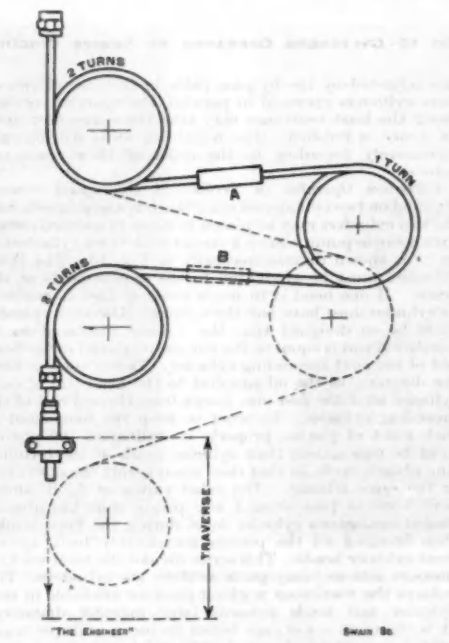


FIG. 17—FLEXIBLE PIPING

(7) *Shaping Machines.*—The limited application of hydraulic power to the operation of shaping machines is divided into two types, one in which the oil pressure system constitutes merely a speed-controlling element between the electric motor and crank mechanism, and a second type in which the hydraulic drive is employed directly for the actuation of the shaper head and for the control of the table movements.

Hydraulic Vice.—It is somewhat remarkable, in view of the rapid developments of pneumatic clutches and work-holding devices, that more use is not made of hydraulic means for this purpose, particularly on machines where surplus pressure oil is available.

The author's arrangement for a vice operated in this fashion is shown in Fig. 16, and is fitted with movable jaws to suit the character of the work. In operation, pressure oil is admitted at A or B for clamping or loosening the work. Travel of the piston C in direction of the arrow opens the links D and through toggle action at E forces the jaws in an inward direction for clamping. A tap on a reverse valve is used for controlling the entry of oil to ports A and B.

As it is often necessary to be able to move attachments of this kind over a limited distance, some non-rigid connection to the oil supply is useful. Telescopic piping and flexible tubing are generally employed with varying success, so that the arrangement, Fig. 17, is put forward as a satisfactory alternative under many circumstances. The piping is seamless drawn-steel tubing, bent as shown, and is found suitable for being sprung from the given position to the extent of the dotted lines without any trouble under severe conditions from fluctuating pressures and vibrations of the pressure oil.

The success of the arrangement is due to the coiling of the tube, two turns near the unions and one for the centre coil allowing movement in all directions and being entirely free from vibration. The joints at A and B are not required, but denote the jointing positions if short lengths of piping only are available.

(To be continued.)

SIXTY YEARS AGO.

THE inscription on the Monument, hard by London Bridge, accusing the Papists of having started the Great Fire of 1666, has long since been removed; but there is still another object in the Metropolis which continues to "rear its tall head and lie." Perhaps, it would be more correct to say that the red granite obelisk which stands on the Thames Embankment near Waterloo Bridge has had falsehood thrust upon it. Its hieroglyphic inscriptions contain references to Thothmes, and Rameses, and other kings of ancient Egypt, but not a word about Cleopatra. It is certainly far older than Cleopatra, yet it is known, and probably always will be known, until the London atmosphere crumbles it to dust, as her "needle." It is believed that it and a similar obelisk were originally erected at Heliopolis and that many centuries afterwards they were carried to Alexandria and there set up in front of the Temple of Cæsar. Its fellow survived the ages in an upright condition, but it, itself, fell, and as long ago as 1610 it was recorded that it was half buried in sand and rubbish. In 1819 Mehemet Ali presented the fallen obelisk to the British Government, but the Ministers of King George IV. decided to leave it where it was. For another fifty years it remained beneath the sand of the Alexandrian seashore, an object of great interest to antiquarians and historians, but rejected as an ornament for London. Certainly, it was no mean problem to devise a way of embarking this prostrate stone, 64ft. in length and weighing 284 tons. But Major-General Sir James Alexander was not daunted by the task, and in our issue of December 13th, 1872, he expounded his plan for bringing the "needle" to London. He proposed to excavate the sand on either side of it, to lay down rails in the trenches, and on each rail to erect a framework mounted on a number of wheels. The two frameworks were to be tied together along their top edges by iron beams straddling the needle, and from these beams rods were to descend to engage with carrying bars inserted beneath the needle. When the rods had been tightly screwed up, the sand remaining below the needle was to be excavated so as to leave the stone suspended by the rods from the cross beams of the framework carriage. Further excavation and rail-laying would then enable the carriage and needle to be moved forward down the shore. At the end of the railway a ship's hull sent out in sections from England was to be erected on a slipway. A portion of the bow end of the ship was to be left off and through the gap the railway was to be continued into the interior of the hull. When the carriage and the needle had been safely stowed within the hull the bow end was to be completed and the ship towed to London. With certain modifications this scheme, or something very like it, was eventually carried out in 1877. The Government refused to meet the expense involved in the work of transportation, but a kindly benefactor was found in the person of Sir Erasmus Wilson, the eminent surgeon and philanthropist, who undertook financial responsibility for the scheme. A storm of great violence arose while the needle was being towed through the Bay of Biscay. The tow rope parted, and for a time it appeared as if the ancient obelisk was to find a lasting place of rest at the bottom of the sea. The adventure, however, ended happily, the expedition reached the Thames in safety, and the obelisk was erected in 1878 on the spot whereon it now stands. To-day, it is the object of a certain amount of anxiety, for the slow attack of our atmosphere, combined with the damage done to it by a German bomb during the war, seems to promise the decay of its inscriptions at no distant date. The twin obelisk which was still erect in 1872, was taken to the United States in 1880 and re-erected in New York's Central Park.

Railway and Road Matters.

THE Parliamentary Notices for the present session of the four grouped companies contain, with one exception, no application for powers to make new railways. The exception is that the Great Western desires to build a curve at Westbury and another on the Malmesbury branch.

SINCE the Great Western Railway Company instituted, fourteen years ago, as a pioneer in railway service, a staff suggestions scheme, over 43,500 suggestions have been received and they now average ten a day. The suggestions relate to traffic questions and matters of train operation and safety in working.

ON the retirement of Sir Walter B. Clode, K.C., from the office of President of the Railway Rates Tribunal, Mr. Bruce Thomas, K.C., was appointed to succeed him as from November 26th last. Sir Walter Clode was originally appointed President of the Railway Rates Tribunal in November, 1922, and has held office since that date.

THE G.W.R. Company is adding 175 to its present stock of 1248 containers. This is a result of the increasing popularity of containers for all types of traffic, particularly for furniture removals, for which a new type of container is to be constructed. This type will have slotted sides enabling the various articles to be firmly secured during transit. In December, 1929, the company's stock of containers numbered 418.

IT was intended to launch, on Tuesday, November 29th, at the yard of Denny Brothers, Ltd., Dumbarton, a new steamer for the Newhaven-Dieppe service of the Southern Railway and the French State Railways jointly, but owing to a gale the launch had to be postponed. The new steamer will be a sister ship to the "Worthing" and will be the fifth cross-Channel steamer to be called "Brighton." The first was put into service in 1847. She will have a speed of 25 knots.

THE sequel to the grouping agreement between the London, Midland and Scottish and the London and North-Eastern companies is that there is no longer any need for such jointly owned lines as the Cheshire Lines and the Midland and Great Northern Joint to be operated by an independent set of officers and staff. A difficulty that might thus arise has been met by the appointment of Mr. S. T. Burgoyne, the manager of the Cheshire Lines, to be the passenger manager of the North-Eastern area, London and North-Eastern Railway, in place of Mr. J. T. Naisby, who retires at the end of the year.

THE first main line electrification scheme of the U.S.S.R. has recently been completed, says *Modern Transport*. It comprises the 40-mile section from Zestafoni to Khashuri on the Batoum–Baku line, where continuous gradients of 1½ to 3 per cent. predominate. The electrification is carried out on the 3000-V D.C. system, and the eight 2725 H.P. locomotives placed in service are equipped with regenerative braking. Two of these locomotives were built in the United States, most of the equipment for the remainder being constructed in Russia. A further seven locomotives, which are now being put into service, have been built in Italy.

THE whole of the Bangor section of the Belfast and County Down Railway, 13 miles in length, is now protected by automatic signalling, and the only signal-box in continuous use is at Holywood, where some of the trains from Belfast terminate and reverse. The line between Holywood and Bangor, 7¾ miles, has just been done, and the work is of interest because the signals are of the banner type and, further, they are approach lighted, *i.e.*, a coming train illuminates its own signals and extinguishes them after passing. The banner signal was invented by the late W. R. Sykes, and the present work has been carried out by the W. R. Sykes Interlocking Signal Company.

THE speed by which train movements are made is gauged by what is shown in the Railway Returns, as the train miles per train-hour and per engine-hour. The coaching train figures were 14·72 and 11·66 respectively in 1931 as against 14·59 and 11·55 in 1930. The freight train miles per train-hour rose to 9·11 from 8·83, and per engine-hour increased from 3·53 to 3·61. The length and weight of the freight trains must, however, be considered in that relation. In all these respects there was a falling-off; the average number of wagons per train decreased from 34·14 to 34·12; the proportion of loaded to total wagons from 66·91 per cent. to 66·44 per cent.; the average wagon load decreased from 5·59 tons to 5·50 tons; and the average train load from 127·71 tons to 124·73 tons.

LOCOMOTIVES owned in America on October 1st, 1932, stated Mr. M. J. Gorman, at the American Railway Association meeting, totalled 52,936, a reduction of 12,135, or 18·6 per cent., compared with the number owned in 1924, which marked the highest number on record in any one year. At the same time, there has been an increase of 16·4 per cent. in the tractive power of locomotives and, for the ten-year period, an increase of 19·4 per cent. Freight cars owned by the railways of the United States now total 2,141,647, a reduction of 223,025 cars, or 9·4 per cent. compared with the number owned in 1925, when the ownership was the highest on record. The average capacity of freight cars to-day, however, is 47·07 tons, an increase of nearly 2½ tons since 1925 and an increase of 3·71 tons in the past ten years.

FOR service on Anglo-Scottish expresses between London and Edinburgh and Glasgow, there has recently been completed at the Wolverton works of the London, Midland and Scottish Railway the first of a new series of corridor brake composite (first and third-class) coaches built to the design of Mr. W. A. Stanier, the company's Chief Mechanical Engineer. Among new features of interest incorporated in these vehicles are the provision of arm-rests and specially sprung and upholstered seats in the third-class compartments, improved interior lighting to enhance the comfort of passengers while reading, and chromium-plated finish to interior metal fittings. The vehicle has one and a half first-class and three and a half third-class compartments, seating in all six first-class and twenty-one third-class passengers.

Notes and Memoranda.

SHEETS of steel, made by the Sandvik Company, only 0·003 mm. thick, are on exhibition in Stockholm.

IN the United States it is considered that natural daylight will adequately penetrate office buildings to a depth of 27ft. if the rooms are 11½ft. high.

SNOW removal from the roads of Ontario costs from 80 dollars to 220 dollars per mile. The cost in Montreal is 290 dollars. The snowfall in Quebec last winter averaged 116in.

THE pipe line which supplies Churchill, Manitoba, with water has been insulated with a 4ft. covering of moss cut from the muskeg. It requires about 5000 tons of moss to cover a mile of pipe.

IT is said that the Delaware and Hudson Railroad Corporation has developed a process of manufacturing steel railway sleepers by means of which their cost has been brought down to 4 dollars each.

IT is now said that the "spotting" of fish shoals from aeroplanes, for the guidance of fishermen in the open sea, has proved to be too costly and uncertain to be of any practical value to the national fisheries.

A REINFORCED concrete pavement over 1000ft. long by 46ft. wide and 8in. thick, laid over made ground in Toronto, settled transversely. It was brought up to grade by boring holes at 15ft. centres and forcing in cement grout under air pressure. The pavement was raised in lifts of 1½in. without any transverse cracks developing.

IN New Zealand a high-level water tower of 3,000,000 gallons capacity, having a minimum diameter of 84ft. and a minimum top water level of 85ft. above the foundation level, has been constructed out of steel with arc welding, and the cost of the water tower worked out very much lower than it would have been had reinforced concrete been adopted in the design.

A CORRESPONDENT of the *Electrical Times* has had occasion to deal with a battery-charging set, consisting of the usual engine, dynamo, accumulators, and switchboard. Trouble arose when the auto-out-in came into action, the closing of the contacts splashing the mercury over the edge of the cups. A single drop of lubricating oil was put on top of the mercury in each cup, and since then no further trouble has been experienced.

ACCORDING to a communication by H. H. Laurie in a recent issue of *Machine Design*, three types of X-ray analysis have been developed, all of which are applicable to the metal-working industries:—(1) Analysis by absorption, giving shadow pictures on a film or fluorescent screen; (2) analysis by interference or diffraction patterns; and (3) spectral analysis, a photographic record of characteristic spectrum lines of any material. The first method is the easiest, least expensive, and most readily analysed. Its applications in the field of metals lie in the detection of flaws in castings and welded structures subjected to high pressures or stresses.

ACCORDING to a paper submitted by Dr. G. A. Hankins, of the National Physical Laboratory, to the International Association for Bridge and Structural Engineering, no practical method of non-destructive testing is immediately available whereby it is possible to obtain a positive indication of the quality of the majority of the welds which may be present in a welded steel structure. Certain methods of non-destructive testing are undoubtedly of value in particular cases, but the difficulties arising in the general application of such tests to welded structures are much greater than in most uses of fusion welding. The difficulties, however, may not be insuperable, and it is hoped that investigators will continue their work in the development of such tests.

THE *Physical Review* for October 15th contains an interesting suggestion for a high-voltage generator. It is known that large frictional charges are produced by blowing dust-laden air against a conductor. Experiments show that a charge of 6×10^{-5} coulombs can be produced by blowing 1 gm. of diatomaceous earth, and it is suggested that a machine could be constructed to generate 1 milliampère at potentials of the order of one million volts. An experimental apparatus was constructed in which 1·5 gm. per second of diatomaceous earth was blown through insulating tubes and then through metal tubes arranged diametrically in a spherical corona shield. A voltage of 260 kilovolts was obtained, and a current of 8×10^{-5} ampères could be drawn from the sphere at this voltage.

IN the construction of the framework of the R.C.A. building in New York, four of the columns had to carry a much heavier load than their neighbours. They were consequently made of silicon steel and were fabricated $\frac{1}{16}$in. longer per story than the carbon steel columns that surround them because of their greater shortening under load. This theoretical difference in shortening, it will be noted, is due to the fact that the 20,000 lb. per square inch working stress used for the silicon steel is 5000 lb. per square inch greater than that used for the carbon steel, while the modulus of elasticity for both materials is the same. Beam connections on the silicon columns were detailed as if the beams were level, a necessary expedient if the connection was to be rigid enough for wind load after the silicon steel columns had shortened under load.

ACCORDING to Mr. N. L. Evans, of I.C.I., soda ash is rapidly establishing itself in this country as one of the cheapest means of improving the quality of cast iron, and helping it to meet modern demands. First used simply as a desulphurising agent, it has been found subsequently to have a marked refining and degasifying action on the metal. It helps in the production of sounder castings, which can also be more easily dealt with in the machine shop, and its effects on the economic side of foundry work cannot be neglected in the face of present-day competition. Some of the branches of the iron industry in which the soda-ash process has already gained a firm footing are:—The manufacture of refined pig iron and alloy pig iron; heavy grey iron castings, particularly those used in chemical plant; converter steel castings; malleable castings; and motor cylinder and other high-grade castings which are required to withstand pressure.

Miscellanea.

A LARGE sugar factory is being put up at Dehra Dun, India.

RADIUM is reported to have been discovered in the Nanyuki district of Kenya.

A NITROGEN fixation plant is to be put up at Nagoya, Japan, at a cost of £2,000,000.

A LARGE deposit of magnesite has been discovered near Kitzbühel, in the Austrian Tyrol.

IT is proposed to put up a large paper-making factory at Stoke-on-Trent at a cost of about £500,000.

A LARGE factory for canning fruit and vegetables is to be erected at Aintree. It will employ about 100 hands.

IT is reported that very promising petroleum deposits have been discovered in Zisterdorf in Lower Austria, at a depth of 786 m.

PARIS is to be brought within ten days and London within eleven days of Hong Kong and South China generally by a regular French air mail.

THE 3-mile viaduct connecting Newark, New Jersey, with Jersey City, which crosses the rivers Passaic and Hakensack, has just been opened to traffic.

JAPAN'S only airship is to be dismantled. This decision has been taken by Navy Department officials. The reason is stated to be the high cost of repairs, and the difficulty of refilling the gasbag.

THE Government of Irak has ordered six twin-engine military aeroplanes from the De Havilland Aircraft Company. The type ordered is new, and is a biplane fitted with two "Gipsy Major" inverted engines of 130 H.P. It will have a speed of about 110 m.p.h.

A CASTING comprising 94 tons of metal was made recently at the Newhall Works of the Brightside Foundry and Engineering Company, Ltd., Sheffield. The metal was poured into a mould approximately 9ft. 6in. square by 7ft. deep. The finished product will be an anvil block for a 4-ton drop stamp.

IT is reported that the Soviet Scientific Research Institute for the Peat Industry has succeeded in working out a process for the manufacture of alcohol from peat. At present a semi-large scale plant is being erected for the further investigation of the process. The alcohol is intended primarily for the manufacture of synthetic rubber.

FURTHER delay has been caused, says the *Canadian Engineer*, in the construction of the Wellington-street tunnel under the Lachine Canal at Montreal, by seepage from the canal. The situation is, of course, not as difficult to handle as it was in the spring when a considerable amount of water escaped through the bottom of the canal into the tunnel workings.

WINNIPEG'S new Salter-street viaduct, a structure nearly ¼ mile in length over Canadian Pacific Railway yards, was officially opened to the public on October 26th. The bridge is of the steel deck girder type, with the approaches at both ends of concrete, and the total length of the structure is 2180ft. The concrete and asphalt-surfaced roadway is 50ft. wide, and 7ft. sidewalks on each side make up the total width for the bridge of 64ft.

THE third blast-furnace in the Kossagorskaia Savod Plant, near Moscow, started working a few days ago. It is the largest of its kind for the making of pig iron from brown iron ore, and has a capacity of 697 cubic metres. Its total height is 27 m., and it has been built after the pattern of the third blast-furnace on the Karch metallurgical plant in the Crimea. The projected total output of the Kossagorskaia Savod plant in 1933 is 219,000 tons of pig iron.

THE new letter office extension to the General Post Office, Mount Pleasant, provides the largest sorting office in the world, and 50,000 square feet of sorting area are already open for the Christmas rush. In order to enable work to be speeded up to the greatest extent, unbroken floor space was obviously essential, and the problem of heating was studied from that angle. As a result the panel warming system has been installed. The heating in the main floor space is by means of low-temperature embedded ceiling panels, although small parts of the building, such as the stairs, passageways, and lobbies, are heated by cast iron radiators.

IN the course of an address on "Salesmanship" before the Insurance Institute of London on December 5th, 1932, Sir Francis Goodenough said:—"One of the chief problems of commerce to-day is the securing of the right type of *personnel*, having received a sound, general, fundamental education which has taught them how to observe, how to deduce from facts observed, how to think, and how to act; and then to organise the further education and training of such recruits in the principles of commerce and in the science and art of selling. This is the problem to which employers must give full, thorough, and constant attention, and in order that they shall secure the right candidates for recruitment, they must be prepared to offer prospects of promotion and pay that will attract to the service of commerce the best type of young men and women judged by character and personality, as well as by ability."

THE otherwise rather colourless task of making a search through the specifications in the Patent Office is, says the *Industrial Bulletin* of Arthur D. Little, Inc., at times delightfully enlivened by the appearance of a really funny patent. We have, it continues, been particularly amused by the device for shooting gravel at cows standing on railroad tracks; by medicines reminiscent of the witches' broth in "Macbeth," by dishes containing spikes to prevent meat from slipping away from the unwary diner; by mirror-bearing fish bait designed to appeal to the vanity of female fishes; and by a most ingenious combination grocer's carton, slicer, grater, shreader, fly-trap, and mouse-trap. Issuing such patents is no reflection upon the activities of the Patent Office, whose chief function is to determine whether or not the patent applications presented to them show invention and novelty, and not to conduct investigations into questions of commercial value.

PORTABLE X-RAY LABORATORY

DESIGNED AND CONSTRUCTED BY THE RESEARCH DEPARTMENT, WOOLWICH ARSENAL

(*For description see page 594*).

FIG. 1—LORRY READY FOR THE ROAD

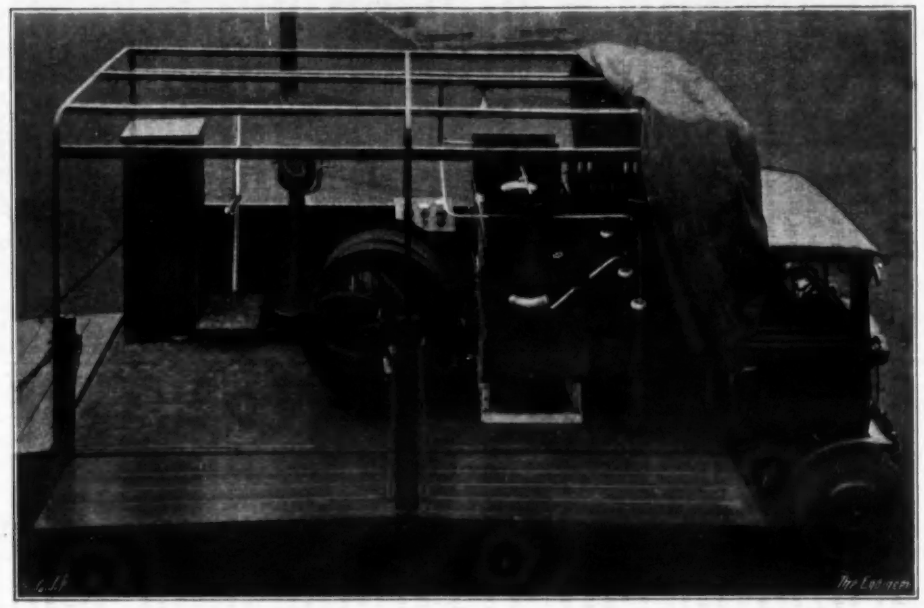


FIG. 2—LORRY WITH CANOPY REMOVED

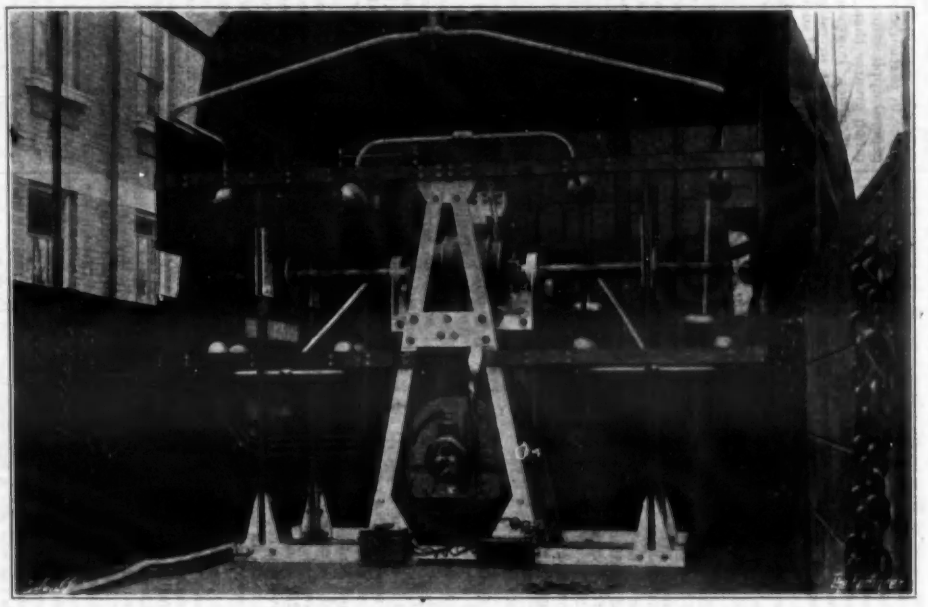


FIG. 3—HIGH-TENSION RECTIFIER

FIG. 4—EQUIPMENT READY FOR OPERATION

The Engineer

DECEMBER 9, 1932.

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BASIC BESSEMER STEEL.

THE year 1929 was, in respect of the production of steel ingots and castings in Great Britain, almost a peak year. The output has, indeed, only once before been exceeded in the history of the industry. It amounted to 9,636,200 tons, of which no less than 8,884,000 tons were made by open-hearth processes. It was actually a peak year in respect of the production of steel in three out of four of the chief steel-producing countries on the Continent. The aggregate production of steel ingots and castings in France, Belgium, Luxemburg, and Germany, and in the Saar in 1929 was, in round figures, 35,000,000 tons, of which 22,000,000 tons were made by the basic Bessemer process. In Luxemburg, for example, 2,669,759 tons of basic Bessemer steel were produced out of a total output of 2,702,257 tons. In Belgium, basic Bessemer steel accounted for 3,595,070 tons, out of a total of 4,109,500 tons. In the year under consideration Belgium alone exported to the United Kingdom 1,462,000 tons of steel manufactures, out of a total importation from all countries of 2,451,000 tons, or approximately 60 per cent., all of which, in addition to most of the remaining tonnage from other Continental countries, must be regarded as having been made by the basic Bessemer process. The foregoing figures may be tedious, but they serve, nevertheless, to bring out in a striking manner the marked contrast between British and Continental practice in the manufacture of steel ingots, and the noteworthy fact that 63 per cent. of the steel made by the principal countries on the Continent is produced by a process which, although it originated in Great Britain, has long since been discarded in this country. That so large a proportion of the steel imported into Great Britain consisted, and still consists, of basic Bessemer steel affords, moreover, conclusive evidence that there exists in this country a heavy demand for such material—a demand which can no longer be satisfied by British steelmakers, and has for years past been left to foreign steelmakers to supply.

It is these considerations which invest with such special and timely interest the announcement that Messrs. Stewarts and Lloyds are about to embark on the undertaking which it has been an open secret for over a year past they have had in contemplation, and are to lay down a large plant at or near Corby, in Northamptonshire, for the manufacture of steel by the basic Bessemer process, thereby reviving a most important branch of the iron and steel industry, which, although flourishing on the Continent, has, from a multiplicity of causes, fallen into complete disuse in the country of its origin. Technical details of the new scheme are not as yet forthcoming, but it is evident from the particulars already made public that it has been conceived on a broad scale, and has all the necessary technical and financial backing needed to secure its success. It is, moreover, one which cannot fail greatly to assist in the general revival of the iron and steel industry, and more particularly of those branches subsidiary thereto—the mining of British iron ores and the production of pig iron, which have of late suffered so severely from the prevailing depression of trade. Continental basic Bessemer steel is essentially cheap steel. That a demand for cheap steel of this description exists in Great Britain is obvious from the import figures instanced above. That that demand can be satisfied, in the main, by the home manufacture, cheaply enough to suit those who have hitherto been buying it from abroad, may be taken for granted. Neither Stewarts and Lloyds nor the Bankers' Industrial Development Company are in the least likely to have embarked on such a scheme without having ascertained fully all the possibilities of the case, the question of costs, and the scope of the market, and having satisfied themselves that not only was the scheme feasible, but that it should prove remunerative as well. Not only, therefore, will they have had in mind the mere replacement of the foreign steel hitherto finding its way into the British market, but it is reasonable to assume that they believe that they will eventually be in a position to supply foreign buyers as well with some at least of the steel which has hitherto been derived almost exclusively from the Continental nations which have made the production of cheap basic Bessemer steel a speciality. The process to be employed must, furthermore, stimulate greatly the manufacture of pig iron, for ordinarily the basic Bessemer process does not involve the use of scrap, whereas the open-hearth process uses scrap in ever-increasing quantities, to the detriment of the pig iron and iron ore industries.

The prospect of the revival, in Great Britain, of the basic Bessemer process opens out, however, issues far wider than those relating only to the replacement, by home-made steel, of part or all of the steel which, to the vexation and embarrassment of the home trade, has hitherto been coming—at dumping prices—from abroad. It raises the question of the possibility of rehabilitating a make of steel which has not only fallen, in this country, into desuetude, but into disfavour as well. Whatever may be alleged against the use of such steel for many of the purposes for which, in this country, it is debarred, the fact remains that those objections are not recognised, and basic Bessemer steel is not so debarred, on the Continent of Europe. It is currently used in France, Belgium, and Germany, to say nothing of most other countries on the Continent, for structural purposes, for shipbuilding, and for the manufacture of railway rails, as well as for the secondary and comparatively inferior uses to which it is put in our own country, namely, in the tin-plate trade, and for tube strip, for which, even in Great Britain, many manufacturers evince a distinct preference for it. How and why did basic Bessemer steel fall in this country into disfavour? There have been many reasons, and not a few unreasons. When the Bessemer process was first introduced metallurgical knowledge of the manufacture of steel was still in a comparatively elementary stage; metallography itself was not born until at least eight years later, and its application to metallurgical research was a development of many years later still. Little was known about oxide or other non-metallic inclusions in steel, and nothing at all of the doctoring of badly over-blown metal with aluminium and other "dopes" used to mask imperfections in the manufacturing process. The phenomena of segregation had hardly been observed, and still less studied. In the manufacture of acid Bessemer steel—the only kind made when the process was first invented—pure materials were needed and obtainable without difficulty. There was no "after blow" to run the metal to a dangerously low carbon point and incur the risk of wild over-oxidised metal. An empirical knowledge of how to make good acid Bessemer steel, slowly acquired, led to the production of reliable metal which complied easily enough with the by no means stringent engineering and other requirements of the day. The acid Bessemer process had several years' start of the open-hearth process, likewise worked with pure materials and well-selected scrap, on an acid lining, and thereafter the two processes progressed side by side. The cheapness and convenience of the Bessemer process were offset by the growing cheapness of scrap, and, be it conceded, by greater ease in controlling the charge in the open-hearth process. Nevertheless, the two processes developed together and have together survived in this country, to the present day, and as both are capable of producing steel of the very highest grade, both are likely to survive. The basic variant of both processes was first described in 1881, by which time the acid Bessemer process had been established twenty-five years and the acid open-hearth process twenty years. The new process had therefore to face the competition of both, and the hostility of the vested interests which had had time to entrench themselves. This situation was, however, peculiar to Great Britain; the Continental nations had not then made anything like the progress they have since made, largely owing to the introduction abroad, of the new process, by metallurgists with no *parti pris*, and industrialists free to adopt a method which seemed to promise cheapness and efficiency. In 1881 the total steel production of Great Britain was one and a-quarter million tons. That of Germany was well under a million. Ten years later the steel production of Great Britain was just under three million tons, of which but one-tenth was made by the new basic process which had originated in that country. A year later Germany had outstripped Great Britain as a steel-producing country, and her output of 3,163,000 tons comprised no less than 2,344,754 tons made by the still comparatively new "Thomas" process, the name by which the basic Bessemer steel process has always been known, in honour of its British inventor, on the Continent.

The inference is one which should be duly noted. In Great Britain the process languished, and with it practice. In Germany it progressed and with it the scientific research and investigation needed to perfect it. Let us admit without reserve that badly made basic Bessemer steel is very bad steel indeed. It was badly made in Great Britain and lost favour. Well-made, it is a material well suited to a host of purposes. It was made well in Germany, in France, in Belgium, in Luxemburg, and in the Saar—wherever, that is, suitable ores and the needful metallurgical skill and scientific knowledge co-existed. The method grew in favour and has become easily the predominant Continental method for the manufacture of steel. As we say, the product is not the best, but it is good enough for many purposes for which the use of the best steel is an unnecessary extravagance. Abroad it has been brought, by painstaking research, to considerable perfection. In Great Britain first neglect and then abandonment altogether of its manufacture has led to the belief that all basic Bessemer steel is bad steel. It has led to its being debarred by engineers for many uses for which it is, when well made, quite suitable. We recognise to the full its limitations, but at the same time we trust that its revival in this country will be regarded with an open mind. It means a great deal to the industrial welfare of Great Britain, and for that reason, if no others, existing restriction on its use should be modified wherever it is safe to do so. The whole open-hearth interest, now more strongly entrenched than ever in this country, is hostile to the revival of the basic Bessemer industry; the discussion of the paper read by Mr. Vernon Harbord at the May meeting of the Iron and Steel Institute last year on the possibilities of such a revival in this country showed that clearly enough. Nevertheless, the last word as to the merits or demerits of ferrous materials, or as to their suitability or otherwise for specific purposes, lies, not with the manufacturer, but with the engineer. The great new enterprise of Messrs. Stewarts and Lloyds will afford British engineers an opportunity of reviewing the whole case for and against basic Bessemer steel, with this new factor in its favour—that it will, in future, be a British product, and not a foreign product dumped into this country to the detriment of the iron and steel industries as a whole.

Unemployment of Professional Engineers.

ALTHOUGH there are fairly strong reasons for believing that the long trough of industrial depression is filling up in this country, many months must pass before what may be regarded as a normal measure of occupation returns. It is estimated that even when that day arrives, not less than one million of the insured population will always be

unemployed. The country has, therefore, to think, not only of the temporary problem of absorbing some two million workers into industry, but of the permanent problem of finding occupation for about a million persons of both sexes. Furthermore, we must face the indications that the working of shorter hours will become an absolute economic necessity, and that means for the proper use of more hours of leisure will have to be offered to many millions who have no idea what to do with themselves after working hours. That something may be done by local and sporadic efforts to satisfy these problems is demonstrated by an illustrated pamphlet, entitled "Unemployment and Opportunity," recently published by the National Council of Social Service, of 26, Bedford-square, W.C.1. This pamphlet shows that in various parts of the Kingdom groups of unemployed workmen have built for themselves workshops in which they make useful articles and toys for their homes; others have undertaken the levelling, draining, and turfing of a parcel of waste land to convert it into a recreation ground; yet others have reconstructed an old Roman bridge over a stream on Blackstone Edge between Chester and York; others are developing allotments, reading up selected subjects, improving their physical fitness by regulated exercises, or keeping their hands in by the restoration of old motor cars. All these things are done in such a manner that they neither jeopardise the receipt of out-of-work pay nor hamper preparedness to take regular employment if and when it is offered.

We have nothing but the highest praise for these efforts, and we trust that the circulation of the pamphlet to which we have referred will cause those who have leisure in suitable districts, and the small amount of organising ability which seems to be called for, to undertake the initiation of similar schemes. But it is evident that in all these cases it is principally, if not wholly, the real working man who is considered. In all schemes and debates on unemployment, we find the same thing. The unemployed of whom the politician thinks are persons insurable under the national scheme, persons of whom very few could ever become leaders of industry or could be entrusted with great responsibilities. It is forgotten, perhaps, that there is much unemployment in higher walks of life, and that unless it can be checked, the result upon the future progress of industries must be serious. Professional men—and we think first of engineers—are suffering very severely from the slump. Many of them were in the employment of works which have closed down entirely, or been obliged to reduce their technical staffs, whilst others were in private practice. Many of them were men who were settled in life, men with young families that have to be housed and fed and educated. For a time they held on, but their resources are being exhausted, their investments have failed them, and those relations to whom they might turn for help are in as serious a plight as themselves. These men get no assistance from the State, and if it were not for the aid given by benevolent institutions of one kind and another some would be reduced to absolute penury. But there is yet another class whose ill fate is of even greater national importance. We refer to the thousands of young men who are being trained annually as professional engineers, and can, at the moment, find no occupation or even pursue their workshop training when they leave colleges and universities. It is a national necessity that they should not be wasted. Industry will need them in due time, for it cannot hope to progress without a considerable proportion of technically and scientifically educated men. Brains and trained intelligence will always be wanted, and it must be regarded as a very serious disaster that thousands of college graduates are now being driven into occupations in which their special talents will grow stale or die. We fear that too little attention has been paid to this aspect of the unemployment problem. The significance of what is happening has not been appreciated, and very little effort has been made to prevent the coming of what may prove to be a serious disaster. We are not thinking of the mere supporting of the lives and bodies of these young men. Probably a large proportion have still sufficient resources to do that for themselves. What we fear is the wastage of trained intellects. It is generally recognised that one result of the slump is that far too few trade apprentices are being trained. But is it so often remembered that a proportion of educated men is also necessary in the engineering industry, and that they, also, are not receiving the necessary training?

Here is a question in which the engineering Institutions and Societies of the country might with advantage interest themselves, and we are happy to know that one, at least, is giving consideration to it. But it is very difficult indeed to propound definite schemes, and not easy to secure statistics and data. Possibly our own pages might be made a useful medium for the presentation and discussion of proposals, and we shall be happy to find space for letters of a practical nature on the subject. One plan which we put forward tentatively is that college apprentices and pupils should work in pairs. Suppose, for example, that a works ordinarily accepting twenty pupils is unable to accommodate more than ten. Then two pupils would work alternate days or weeks in the shops. The remaining days might be profitably devoted to study, which, no doubt, could be arranged in the local technical schools. By an arrangement of this kind, young engineers leaving colleges would be able to get their training and would not be obliged, as so many are now, to seek employment of any kind, outside their intended profession. With the co-operation of employers we believe such a plan might be set on foot. But we do not advance it as the only or the best possible scheme, and we shall be interested to receive comments upon it and suggestions for other means of meeting a problem that is becoming increasingly urgent.

Salving a Fleet.

IT is not easy to hold the close attention of a large audience for two continuous hours. But that is what Mr. E. F. Cox did when he delivered the Thomas Lowe Gray lecture at the Institution of Mechanical Engineers on Friday last. The hall was filled to capacity and round upon round of applause punctuated the lecture as Mr. Cox told with attractive *naïveté* how he mastered difficulties and one by one recovered from the sea at Scapa Flow all but a dozen of the sunken German fleet.

It was virtually a single-handed enterprise. The idea of salving the ships having come into Mr. Cox's mind, he went and surveyed the field and eventually asked the Lords of the Admiralty if they would "give him the German Fleet." National generosity, even with a useless asset, would not go as far as that, and Mr. Cox had to buy what he hoped to get for nothing. He did not say what sum he paid for it. Having transacted that part of the business, he made ready two floating docks equipped with hoisting tackle, cranes, pumps, and power—see THE ENGINEER, September 4th, 1925—and selecting the easiest subjects first, opened operations on the twenty-six sunken destroyers. They lay on the sandy bottom in all sorts of attitudes—upright, on their sides, upside down, and piled up at steep angles. The problem in every case was to thread many large cables underneath the wreck and to bring the cables up to the two docks so that the vessel was contained in the bights. The first destroyer to be tackled lay upright on an even keel and had sunk but little into the hard sea bottom. It was therefore easy to pass several cables under the overhang of the stern and by hauling on them to tip the hulk up a little on her bow so that more cables could be passed underneath. Step by step, as more lifting power became applicable, cables were worked under the hull until a large number were placed at intervals from stem to stern. Then by manipulation of the hoisting gear on the two docks the destroyer was raised off the bottom between them and so carried to the breaking-up yard some seven miles away.

When the destroyer lay on its side the problem proved to be even simpler, for owing to the form of the deck plans she touched only over the central portion of her length, both the aft and forward parts being "in the air." Hence cables could be introduced without difficulty. But, obviously, the superstructure, funnels, masts, &c., would prevent the wreck from being lifted between the two docks. The raised hulk, hanging in the bights of the cables, was, therefore, carried out to deep water, where by proper handling of the cables, letting out on one side and hauling in on the other, she was made to rotate about her own longitudinal axis until she was upright. She was then raised to the desired height and carried to the breaking-up yard as before.

Boats which lay quite upside down were tackled in the same way, the many deck structures leaving passages through which divers could crawl with the leading cables. Some of the destroyers were found piled up like a bundle of sticks laid for a gipsy's fire, and they, owing to the ease with which the cables could be rove under and around them, presented, after the experience gained, no trouble whatever. So expert did the salvors become that the later boats could be lifted and transported in a few days.

Having raised twenty-six destroyers and so made a sufficient sum to carry on the work, the great task of salving the "Hindenburg" was begun. The story has already been told in our columns—see THE ENGINEER, October 1st, 1926—but it is worth while recalling here a few of the leading facts. The vessel lay on the bottom with but a slight list from the upright, and the intention was to float her by pumping out the water. Forty pumps were available on the two docks, and after the divers had patched a great many openings—ultimately there were 800 patches—the pumps were set to work at the bows. Mr. Cox had anticipated that as the bows rose the "dead wood" at the stern would sink into the sand until the propellers and the stern tube bossings took a bearing and so prevented the vessel from rolling over. Most unfortunately, the "dead wood" happened to be resting on a rock and as soon as the bows were raised the wreck "got up to" what Mr. Cox described as her "funny tricks," heeling over to a dangerous angle. Efforts were then made to pump out the stern compartments, but they were frustrated by the fact that two 24in. pipes ran all fore and aft in the double bottom and in every compartment a drain valve connected to this pipe was open. Hence water flowed into the stern as fast as it was pumped out, and as the valves were inaccessible nothing could be done. After five months of anxious work and heartbreaking disappointments the attempt had to be given up owing to lack of money and was not resumed for three years, when with greater experience it was successfully achieved. Altogether Mr. Cox spent £75,000 on the salvage of the wreck and just got his money back. When the work was resumed the first step was to prevent the listing which had proved so disastrous before. The "Hindenburg" had always rolled to starboard, and to prevent that action a large section cut out of a salved destroyer was set up round the propellers and "dead wood" on the starboard side to form a caisson which was then filled with 600 tons of concrete. The pumping operations were then repeated, but after the bow had come well out of the water the wreck took a list to port! There was, therefore, nothing to do but lower it once more and build a similar concrete block on the port side. Three weeks were occupied in that work, but when it was done the wreck had a broad hinge about which she could be rotated without danger of listing to either side.

The early attempts were made with ordinary centrifugal pumps, which had to be lowered in stages as the suction head increased. For the second attempt Mr. Cox purchased submersible electric pumps, which could be lowered into the water. But instead of endeavouring to work through closed openings he cut a number of holes near the stern, on which tall tubes or funnels extending above the sea level were erected. The pumps were lowered down these funnels and their deliveries were brought up through them so that they could be watched. Step by step the valves to the two 24in. drain pipes were closed and patching was completed. Then, after one or two efforts, the correct rate and order of pumping was found and inch by inch the stern came off the bottom and the great 28,000-ton wreck was in a position to be towed away.

The second big ship with the salvage of which Mr. Cox dealt was the "Moltke," 23,000 tons, which was resting in 70ft. of water bottom upwards with a list of 16½ deg. It was decided to attempt to get her by the compressed air method, and the example presented by the salvage of the "Leonardo-da-Vinci" in the harbour of Taranto—see THE ENGINEER, March 18th, 1921—was taken as a key to the problem. Now, the "Leonardo" had a list of only 8 deg., and when air was pumped into her she shifted on to a level keel (upside down). But, according to Mr. Cox, it was found that if a cruiser was inclined at more than 10 deg. from the vertical the displacement of the water caused her to increase, instead of diminishing, her list. That happened with the first attempt to float the "Moltke," and it was not till steps had been taken to distribute the air on the port and starboard side as required that she was successfully raised. For this purpose lofty air locks were erected on her bottom to give admission to the interior so that the longitudinal bulkheads might be made water-tight.

When she had been floated it was decided to tow her to Rosyth and put her in dry dock, for it was found that the cost of cutting her up in her inverted position was far too great. Mr. Cox told with a good deal of humour his efforts to get someone to undertake the insurance of the inverted hulk and the towage of her through the Pentland Firth and so to Rosyth. It was a stroke of irony that the towage was eventually undertaken by two German tugs! Then when, after a stormy passage, she entered the Firth of Forth, a misunderstanding about the pilot caused further confusion, and it would appear some negligence, for instead of the wreck being towed under one of the spans of the Forth Bridge as intended, she took charge and, amidst roars of laughter, Mr. Cox related how the hulk went by herself under one span whilst the tugs went under another. It was, he said, the first example of a ship sailing by herself, bottom upwards, under the Forth Bridge.

It was nearly eight o'clock when the lecturer had reached this point, but he offered to continue for another hour if the audience wished or, alternatively, would give another lecture. The second offer was accepted with loud acclamation.

The lecture was illustrated by a great number of lantern slides, and the descriptions were illuminated by sketches which Mr. Cox made on the board. The manner of presentation was quite informal and, as we have said, held the attention of the audience

easily for very nearly two hours. At the conclusion the President, in proposing a vote of thanks, said: "We have heard to-night the most thrilling story of courage, enterprise, and determination ever told in this room." No one who attended the lecture will hesitate for a moment to endorse that description of it.

The story of these wonderful salvage operations has been told in successive articles in our columns, and as some of our readers may desire to refer to the illustrations, we give the dates of the issues:—July 8th, 1924; April 17th, 1925; September 4th, 1925; October 1st, 1926; June 1st, 1928; and February 22nd, 1929.

French Railway Organisation.

IN view of the strong opposition to the plan which the Minister of Public Works intended to present to Parliament for an amalgamation of all the railway systems in France, it is understood that the proposal has been withdrawn. This decision, if confirmed, coincides with the publication of the main lines of a scheme for reorganisation proposed by the railway companies themselves, which refused to accept any plan of amalgamation that would involve an unwieldy and inefficient organisation and would probably provide no relief from the heavy burdens imposed upon the railways by the State. In this new plan the companies affirm that, having lost the monopoly of transport which they enjoyed at the time they acquired concessions from the State, the terms under which those concessions were granted can no longer apply. The road, they say, is taking the cream of the passenger and light goods traffic, leaving the railways to deal with heavy goods which are, moreover, being increasingly diverted to the inland waterways. The railway rates are based on the principle that light and valuable goods pay for cheap and cumbrous merchandise, and it follows that if the rates for such merchandise are raised to make up for the deficiency of light goods traffic, national industries will suffer. At present the companies have their hands tied by the State and can do nothing in the way of increasing rates, and fixing their own time-tables and the number of trains in service without State sanction.

The plan they have now presented to the Minister of Public Works is based upon a "commercial equality" of the different means of transport. They ask for liberty to fix rates at the level existing before the franc depreciated, and for full initiative in adjusting trains and time-tables to the requirements of the services. The interests of railway users would be safeguarded by the institution of an Arbitration Court which would settle all questions in dispute between the companies and users regarding rates. The substitution of motor omnibuses and rail motors for trains, and the employment of any new means of working that might be found necessary, are held to come within the initiative of the companies, without depending upon the good will of the State, which has so far not permitted the companies to deal with the problem in their own way. Urgency is needed to place road transport on the same footing as the railways, since both utilise national property, and while the companies have to maintain their tracks, the State imposes taxes on them to the extent of about 2000 million francs a year. The traffic, say the companies, should be distributed in a way that would be to the best interests of all concerned, for which purpose they propose the creation of a National Company that would carry goods from door to door. The National Company would be constituted by the railway companies, the Post Office Department, and the road transport concerns. This national transport company is obviously intended to offer a solution of the whole problem. The railway companies would benefit from it to the extent that they would have a guiding hand in its operations and a share in the profits; the Post Office would have to pay for the carriage of mails by rail as well as by road, which it does not do at present, and as the road hauliers would be brought into the National Company they might possibly extend their share of the road traffic, though, under conditions that would not make the road a competitor of the railway. Both would be absorbed into one homogeneous transport system.

Of no less importance to the working of the railway systems is a proposed re-arranging or grouping of interests wherever desirable, such as the fusion of purchasing and publicity services on neighbouring systems and the preparation in common of types of rolling stock. The transference of certain lines from one company to another, which is more favourably situated for working them successfully, is also suggested. This work of co-ordination would be undertaken by a central committee which would fix the programme to be carried out by the different companies in the way of ordering rolling stock, the construction of new lines, and the carrying out of other works. As the central committee would be composed of representatives of all the companies, it would be able to deal with matters more promptly than is possible with the existing Comité Central des Chemins de Fer, which represents all classes and can only make recommendations for submission to the Government. At the same time, a representative of the Government would be permanently attached to the proposed committee so that the Government would be completely informed of all the details of railway management. The State would be required, for its part, to reduce the tax on railway fares from 32·5 per cent., which was imposed as a temporary measure at the time the franc collapsed six years ago, to 12 per cent.; to pay for the carriage of mails and for other public services; and to authorise the companies to reduce wages to a level justified by the present economic situation, as the State is now doing in the case of its own civil servants. The companies have already effected economies this year to the extent of about 1000 million francs, though the estimated deficit is still 4000 million francs, and they affirm that if the State had carried out the terms of the Convention of 1921, and the companies had been allowed to adjust railway rates to meet the additional expenditure imposed upon them by the State, there would have been no deficit, except that probably arising from the economic crisis. They further state that if their plan is adopted the coming year will see an end to the annual deficits.

This plan crystallises the reports and schemes which the companies and independent experts have presented during the past two years, and it offers a well-considered way of escape from the present apparently inextricable difficulties, the only reservation made by the companies being that the State should take over one half of the total deficit which the Minister of Public Works himself attributes to the economic crisis. Relieved of one-half of their burden, the companies are convinced that, with freedom to conduct their business on purely commercial lines, they would be able in time to wipe out the remainder, which continues to accumulate at the rate of nearly 100 million francs a week.

There is no alternative to the plan, save the Socialist proposal of the Minister of Public Works, which is condemned by everyone outside the Socialist Party in the Chamber of Deputies.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

A WORLD FEDERATION OF ENGINEERS.

SIR,—On page 513 of your issue of November 18th you devote, as we have noted with pleasure, an article to the constitution of a European Federation of Engineers.

The idea of a World Federation of Engineers was first conceived in 1923 by the Society of Czechoslovak Engineers, and, at the instigation of the Masaryk Academy of Work in Prague, was first made public in an address by the Czechoslovak Minister at Washington, Dr. B. Stepanek, at a banquet held on the occasion of the annual meeting of American engineers. The speaker afterwards received many letters of very hearty approval from eminent American engineers.

The reason why Czechoslovak engineers were the first to put forward this proposal was that, belonging to a small nation, they felt all the more the necessity of solidarity of all engineers in order that the great task of making good the damage caused by the war might be accomplished, and also because they felt that the world was faced at the time by an epoch-making change in the life of mankind, especially as regards production.

Another, not less important, reason was the fact that the greatest statesmen of the world, in concluding the peace treaties, overlooked their own profession, the intellectuals, and in their apprehension of the Workers' International, they created the International Labour Bureau, wherein, however, only the *entrepreneur* and the workers are represented, whereas engineers, the connecting link between the two and mediators in differences relating to the work of production are entirely left out.

In starting work, the Directors of the Bureau soon became aware of the error that had thus been committed, but they were unable to remedy it, because any change requires the consent of the thirty-nine States which participated in the making of the peace treaties. Therefore engineers are only called upon from time to time with reference to problems which could not be solved without expert technical advice. In the most important institution of work engineers are therefore no more than assistants.

The oversight would not have happened if an International Federation of Engineers had at the time been in existence.

Finally, we are of opinion that engineers occupy a subordinate position in public administration, even of the most civilised States, because they are not organised as other professions. Of course, according to our opinion, engineers themselves are mostly to be blamed for this state of affairs, for, as can be seen from the peace treaties, only those count that can impress by the might of their organisation and by their numbers.

However, the present world-wide crisis requires surely help also from our profession.

In making our proposal for the creation of a World Federation of Engineers we have been animated by moral motives, rather than by utilitarian ones, contrary to the spirit of the times. The Czechoslovak engineers submitted the proposal for the creation of a World Federation of Engineers at the World Congress of Engineers in Tokio. Its authorship, however, has not been mentioned in your paper. The Congress decided that this proposal should be considered by all engineering corporations of the world, and that they should be invited to state their opinion about it.

In the meantime, the Czechoslovak engineers have created a Slav-Slovanic Federation of Engineers, which has now been in existence for some years, and is the first stone in the building of the new international organisation.

Some time ago we received information from the United States of America which is not very favourable to this suggestion, chiefly, we believe, because in the United States the opinion now prevails that it is best to keep aloof from European affairs. However, we have good reason to think that this opinion has already undergone a change, on account of the world crisis, which shows that all parts of the world are so bound together economically and morally that not one of them can exist without the other.

We were greatly pleased when Mr. Guiselin, the French engineer, returning from a conference with our colleagues, the Polish engineers, called on us at Prague two years ago, and we are greatly indebted to him that, thanks to his efforts, a Committee of Initiative has been created in Paris, and the idea of the formation of a European Federation of Engineers has been taken up by the most prominent people in France, which has ever been the pioneer of progress and a faithful supporter, as well as model, for small countries.

We know also that our Spanish colleagues have received the suggestion with feelings of sympathy, which we also cherish towards their ancient and flourishing country.

We also beg to state that we have sent to Paris a draft of a statute for the Federation, wherein questions to be dealt with by the Federation are indicated, as you mention in your paper.

There will, of course, arise difficulties in the path of the new Federation, but good-will and the present crisis will no doubt bring about agreement. Although we have, above all, moral questions and public service in view, for only in this way shall we enlist the support of the public, which alone can help us to obtain a just recognition and status, we do not mean to shut out the spirit of enterprise, as indicated in your programme of European public works. This is certainly another reason for the urgency of the creation of a European Engineering Federation.

I trust that you will continue to give the matter your support, and accept kindly this supplement to your article.

EMIL ZIMMLER,
Honorary Member of the Society of Czechoslovak Engineers.

Praha—II., Náplavní ul. 5, November 29th.

SHORT NOTICES.

Applied Building Mechanics. By Arthur D. Turner. Bristol: John Wright and Sons, Ltd. 1932. Price 7s. 6d.—In this little volume, which has been written with the R.I.B.A. examinations in mind, the author has worked out over fifty selected building problems without the help of advanced mathematics. We observe that graphical methods have been largely used, but the author sticks to first principles and does not seek short cuts. As an indication of its contents we may mention that Bending Diagrams; Frames and Joints in Wood; Steel Frames; Stanchions; Ferro-concrete; and Masonry and Brickwork are all dealt with, amongst other subjects. Judging from a general inspection, we do not doubt that the volume will prove useful not only to students, but to designers and architectural draughtsmen.

BOOKS RECEIVED.

Berechnung gegliederter Knickstäbe. By Dir. Dr.-Ing. D. Rühl. Berlin: V.D.I. Verlag, Dorotheenstrasse, N.W.7. Price 5·50 marks.

Gas Calorimetry. By Major C. G. Hyde, M.C., and F. E. Mills, B.Sc. London: Ernest Benn, Ltd., 154, Fleet-street, E.C.4. Price 42s. net.

L'Egypte et ses Chemins de Fer. By L. Wiener. Cairo: Congrès International des Chemins de Fer, 16, Avenue de la Reine Nazli, Egypt. Price not stated.

Business Budgets and Budgetary Control. By A. W. Willsmore. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C.2. Price 10s. 6d. net.

Wilkin's Elementary Heat and Heat Engines. Second edition. Revised by E. Griffen, M.Sc., &c. London: Oxford University Press, Amen House, Warwick-square, E.C.4. Price 5s. net.

IN 1931 the first two Soviet blooming mills were manufactured, and they are being installed at the Makayevka and Kamenskoye steel plants. In addition, four new blooming mills are being set up at the Magnitogorsk, Stalinsk, Noginsk, and Zlatoust works. The Magnitogorsk blooming mill alone has a capacity of nearly 1,000,000 tons a year. Further, over a dozen new rolling mills have either already been put in operation or are now under construction. At the Stalinsk works the construction of a rail mill with an annual output capacity of 650,000 tons of rail is nearing completion, and will start production during the present quarter. The rolled metal department of the Magnitogorsk steel mill, when completed, will be one of the largest in the world. It will consist of three blooming mills, each of 900,000 tons capacity, and thirteen rolling mills. The annual capacity of the entire department will be 1,450,000 tons of iron shapes and 1,200,000 tons of rails. This considerably exceeds the output of the largest metallurgical plant in Europe.

A Portable X-Ray Laboratory.

By V. E. PULLIN, Director of Radiological Research, Woolwich.

THE increased use of radiology in the consultative examination of engineering structures has rendered it necessary to consider the provision of portable equipment of high power and considerable flexibility in operation. The expense involved in transporting heavy structures to a fixed radiological laboratory has often meant that X-ray examination has had to be omitted in cases where it was highly desirable. There are, of course, portable industrial X-ray sets of high efficiency and exquisite construction now available commercially. Such sets have many applications, and no doubt will very soon be in general use in engineering works.

These notes are written to describe a transportable complete X-ray laboratory which has been designed and constructed in the Research Department at Woolwich. It is intended that the laboratory, in charge of a qualified radiological physicist, shall at all times be available for use in any of the Service factories, depôts, or dockyards in the country. It will be seen from the following description that the high-tension transformer is operated by the lorry engine, and hence that the operation of the laboratory is independent of external power supply. A portable dark-room, with complete equipment, is also carried on the vehicle, and apparatus for crystal analysis may also be conveyed if required. The presence of an experienced engineering radiologist will ensure that every possible aspect of radiological technique is brought to bear on any problem which may be submitted. The tube may be operated on the lorry itself, or, if necessary, it may be operated up to a distance of 30 yards from the lorry by means of *earthed* high-tension cables. The apparatus is mounted permanently in the lorry and no time is therefore lost in erecting the equipment on arrival at the site of the work.

Fig. 1, page 590, shows the lorry ready for the road, and Fig. 2 illustrates it with the canopy rolled back and shows the general assembly of the apparatus, the dark-room having been removed. The high-tension transformer, rectifying apparatus, control panel and earthed high-tension cable should be specially noted. The lorry is a 50-cwt. four-wheel vehicle, with a total floor area of 14ft. by 7ft., and an internal height of 7ft. A power take-off shaft has been added, whereby the engine may be coupled to the alternator to provide the electric power required. The operation of changing from road running to the alternator drive is controlled by a lever in the driver's cab. A special governor has been fitted to control the engine speed within the limits of $\pm 1\frac{1}{2}$ per cent. for a predetermined speed. The governed speed is 1500 r.p.m. on the alternator shaft. The lorry is fitted with balloon tires to minimise vibration, and the apparatus has been carefully arranged and fitted to contribute to the same end. The alternator, Fig. 5, is chain driven from the power shaft. It is of the single-phase, self-excited type, and is capable of delivering continuously 5 kW at 250 volts, 50 cycles, 1500 r.p.m. A voltage regulator keeps the voltage constant from no load to full load. Fig. 6 shows the two high-tension transformers with the filament heating transformer in the foreground, while behind is the voltage distribution board. Each transformer is rated to give 150 kV and 10 milliampères continuously. One end of the secondary is earthed. These two oil-immersed transformers are supplied in parallel from the alternator at voltages up to 250. They have their secondaries connected in series to form a 300 kV system with the centre point earthed.

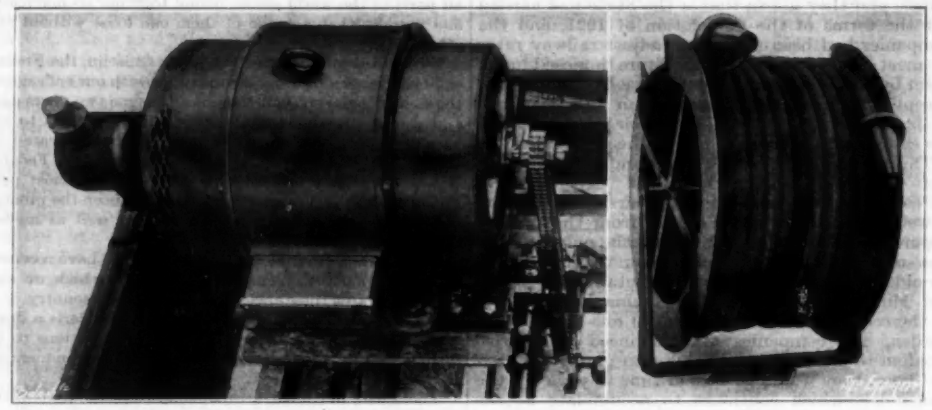


FIG. 5—CHAIN DRIVEN ALTERNATOR AND CABLE DRUM

The lay-out of the high-tension rectifier is illustrated by Fig. 3, page 590. The operation of rectification employs a mechanical system whereby the cross arms are rotated by a synchronous motor. The collecting segments are of accurately machined aluminium. The apparatus is designed to rectify 300 kV. It is mounted on rubber pads to reduce vibration. The general utility of the equipment turns largely upon the successful development of earthed high-tension cables, which can trail on the ground, and can safely be carried through any shop or factory. Special cable ends designed and made in the Research Department are used for the connections to the H.T. generator, and also to the X-ray tube. The cable is carried on a rotating drum affixed by a rotary member to the floor of the lorry. The cable on the drum and one pair of cable ends are shown in Fig. 5. The cables are sheathed in flexible metal and covered by impregnated cord braid to withstand rough use.

The X-ray Tube is a Philips Metalix (F. 300), rated at 260 kV and 6 milliampères, with forced water cooling. There is a separate pedestal pump. A protective relay circuit arranged in conjunction with the tube is designed to prevent H.T. being applied to the tube before the water is circulating. It also cuts off the voltage if for any reason the water supply ceases. The control of the equipment is effected by means of a trolley pattern switchboard, which is normally operated in a position close to the X-ray tube. It is connected to the main distribution board by means of an armoured flexible cable. The H.T. voltage is controlled by an auto-transformer, which allows the voltage to be raised in steps of 10 volts. A voltmeter and a low-tension milliampèremeter are mounted on the trolley switchboard and the switches are of the contactor type. The dark-room folds up into two comparatively light boxes for travelling. It can be erected as shown in Fig. 7 in five minutes, and can either be used erected on the lorry or apart from it. It is completely fitted with all photographic requirements and apparatus, including water and heating systems, ordinary and safe lights, viewing screens, &c. Its internal arrangements, when erected, are shown in Fig. 8. The dimensions of the room are 6ft. by 4ft. 8in. by 7ft. high.

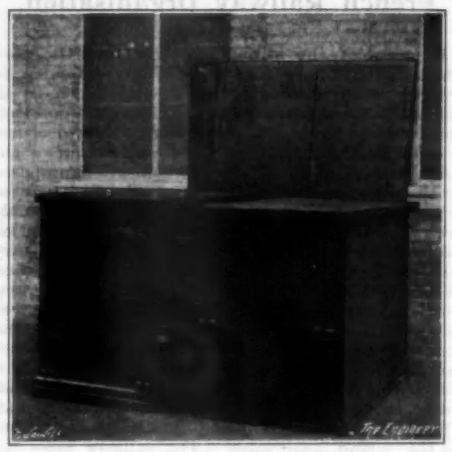


FIG. 9—DARK-ROOM FOLDED

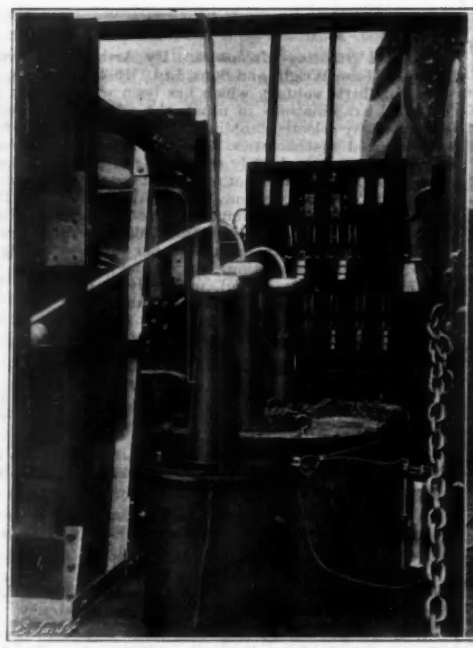


FIG. 6—H.T. TRANSFORMERS

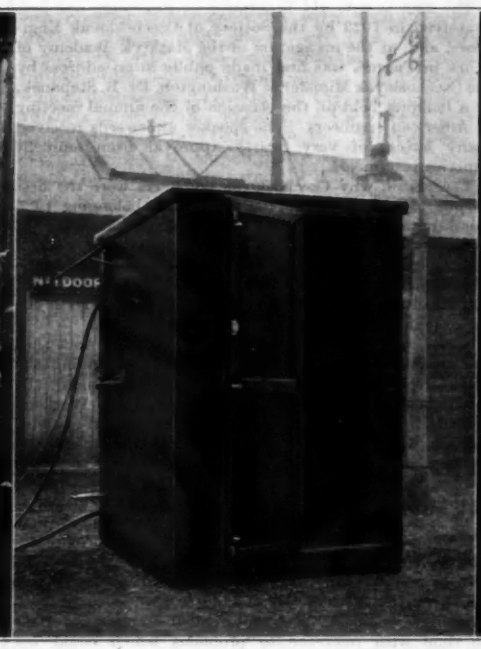


FIG. 7—DARK-ROOM

FIG. 8—INTERIOR OF DARK-ROOM

The whole equipment ready for operation is seen in Fig. 4, page 590. Engineering structures up to a thickness of 4in. of steel may be examined by this equipment, and it is hoped that its portability and power, combined with modern advanced knowledge of the interpretation of engineering radiographs, may prove of considerable value to the Services, for the use of which it has been constructed.

EVERY week the G.W.R. uses about 40,000 tons of coal. The increase of but 1 lb. per engine per mile means an annual increase of £36,000 in the company's coal bill, while a similar amount dropped from the engine footplate represents the loss of a ton of coal a day.

SYNCHRONOUS CONDENSER AND TRANSFORMERS.

THE METROPOLITAN-VICKERS ELECTRICAL COMPANY, LTD., MANCHESTER, ENGINEERS

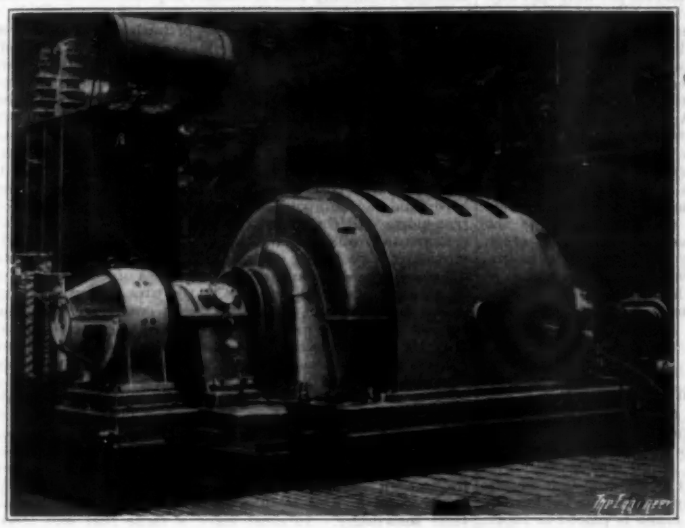


FIG. 1—20,000-kVA SYNCHRONOUS CONDENSER

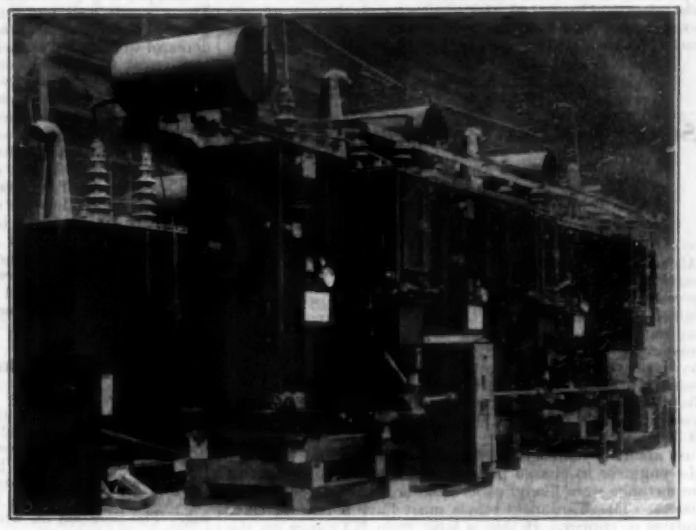


FIG. 2—BANK OF SINGLE-PHASE TRANSFORMERS

Large Synchronous Condensers.

THREE large three-phase totally-enclosed synchronous condensers for voltage regulation on a 40-kV transmission system have recently been built by the Metropolitan-Vickers Electrical Company for the Victoria Falls and Transvaal Power Company. Each machine is rated at 20,000 kVA, 10,500 volts, 50 periods, 1000 r.p.m., and as they will operate at an altitude of 4300ft., with an ambient temperature reaching 43 deg. Cent., the temperature on the occasion of the shop tests had to be 10 deg. below that of British Specification No. 226. One of the machines is to be installed in the existing Robinson compressor station, while the other two will be placed in a new distributing sub-station at Vlakfontein. As they will only work with a leading current, a simple system of excitation control has been adopted. The machine at the Robinson compressor station is to be used with a water-cooled air cooler working on the closed circuit system, while the two condensers at Vlakfontein will take the air through Visco filters and after passing through the machines the air will be discharged through ducts to the outside of the station.

TRANSFORMERS AND TAP-CHANGING GEAR.

Each condenser will be connected to the line through a bank of three 6667-kVA single-phase outdoor transformers (Fig. 2), having a ratio on full load of 40,000/10,500 volts, and provided on the H.T. side with off-load tapping switches to allow for variations in the line voltage from 42,000 to 36,000. As the transformers are delta connected on both sides (see Fig. 3), in the event of a fault developing in any one unit the remaining pair can operate at reduced output in open delta. A supply for auxiliaries is taken from the 10,500 terminal, whilst the current at reduced pressure for starting the condenser is provided by on-load tap-changing gear, which, so far as is known, has not previously been used for starting purposes. As will be seen from the diagram, Fig. 3, while all the transformers are fitted with tap changers, only two in each bank are actually used, and it will also be noted that one transformer is reversed, so that the condenser is started from one corner of the delta connection. The transformers, which are constructed in accordance with the makers' standard practice without the use of wood, are two-leg core type units, and are forced cooled by circulating the oil through separate coolers. The on-load tap changer consists of two selector switches per phase and two circuit breakers.

SYNCHRONOUS CONDENSER.

The fabricated steel stator frame of each condenser (Fig. 1) is designed to discharge the air at the bottom, where there is a connection to the air cooler or air outlet duct. The two-layer diamond coil type winding is placed in open slots, and in order to secure a sinusoidal wave form by eliminating the lower harmonics and to minimise additional load losses, short pitch coils have been used. Although a whole number of slots per pole have been adopted, high-frequency harmonics due to the slots have been entirely eliminated by a small displacement of the field poles in alternate directions. Each stator coil consists of a single turn built up of a number of small rectangular conductors, each separately insulated by a treated asbestos covering. Every component conductor in all the connections between coils is formed separately by electric welding. At the joints the strips are transposed step by step, so that there is a complete transposition of all the strips in each phase, with the result that no circulating currents can exist. The winding losses are said to have been reduced to a minimum; in fact, additional load losses in these machines have been almost entirely eliminated. Adequate precautions have also been taken to secure the stator coils against short circuit forces.

The six-pole rotor has no damper winding, the machine being started and synchronised by currents induced in the solid steel pole faces when a reduced voltage is applied to the stator. The magnet wheel consists of a steel casting, the six-pole projections and the rotor body being cast in one piece cored out at the centre to reduce weight. The journals are formed on separate flanged shafts, machined from steel forgings, spigotted, and bolted to the magnet wheel at either end. The field coils are composed of strip copper wound on edge on a former, and are constructed so that every fifth turn projects beyond the others at the ends of the coil, so as to form a cooling fin. The poles are completed by solid shoes on tips composed of rolled nickel steel, attached by a large number of nickel steel bolts, with their heads recessed into the pole tips. After assembly, the surfaces of the pole shoes were machined on a profile planer to reduce the radius, thus improving the wave form of the machine.

Axial flow fans, each consisting of twelve blades composed of a special aluminium alloy and bolted to a heavy steel ring pressed on to the ends of the shaft, provide the ventilation. The exciter, which is overhung on a flanged shaft, spigoted and bolted to the end of the condenser shaft, is a simple shunt-wound machine, controlled by a shunt field rheostat.

Low-pressure oil circulation for the two bearings is provided by a "Rotoplunge" pump, driven from the

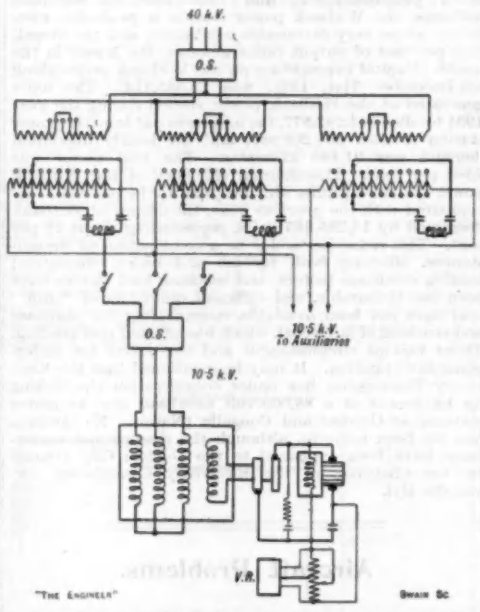


FIG. 3—CONDENSER AND TRANSFORMER CONNECTIONS

main shaft at the back of the machine, through a small Wellman Bibby coupling. The oil reservoir consists of two rectangular tanks, which form integral parts of the welded steel bed-plate at the end near the pump. One of these reservoirs contains duplicate strainers, and the other a water cooler. In addition to a contact-making oil flow relay, each bearing is fitted with a visual flow indicator. In one of the reservoirs there are also two motor-driven gear type high-pressure pumps for injecting oil under the journals during the starting process. In this way the initial friction is reduced to practically zero, and an electrical input of 4 kilowatts is said to be sufficient to start the machine. The motor-driven pumps also serve as a stand-by to the mechanically driven pump, and if the normal supply of oil to either bearing should fall below the minimum quantity required for satisfactory operation, these motor-driven pumps are started automatically by the operation of the oil flow relays. Ordinary ring lubricators are also fitted to the bearings.

STARTING ARRANGEMENTS.

The condenser at the Robinson station will be manually controlled, but the two machines to be installed at Vlakfontein will be provided with semi-automatic starting equipment. In the case of the former installation, the tap changer will be operated by two interlocked control handles, one of which moves the gear over the three starting tappings by three separate operations, while the other causes the gear to pass continuously through the remaining seven transition tappings to full voltage. The method of starting is as follows:—With the tap changer in the No. 1 or "off" position, the field switch open, and the 40-kV switch closed, a starting resistance is connected across the rotor slip rings by a press button operated contactor. The motor-driven high-pressure oil pumps are then started and the 11-kV machine switch is closed. Next, the tap changer is moved on to the No. 2 position, corresponding to the first starting tapping, thus applying 18 per cent. of the full voltage to the machine, which starts, accelerates uniformly to full speed, and pulls into step, and when normal oil circulation has been established by the mechanically driven pump, the starting pumps are automatically shut down. The exciter voltage is then adjusted to the value corresponding to no-load excitation, and the main field is closed, the starting resistance being simultaneously disconnected. The tap changer is then moved successively over tappings 3 and 4, and is finally allowed to run through the transition tappings to the full voltage, for which the condenser is already correctly excited. Finally, the voltage regulator is put into service, when the condenser will take up load in accordance with the requirements of the system.

AUTOMATIC EQUIPMENT.

Apart from a slight difference in the control of the tap changer, the sequence of operations in the case of the semi-automatic equipments is the same as that described. The process is initiated by a control handle, which, provided the 40-kV switch is closed, the 11-kV switch open, the tap changer in the "off" position, the main field switch open, and the exciter rheostat in the position corresponding to no-load excitation, will energise the automatic equipment. When the proper oil pressure has been built up by the motor-driven pumps the 11-kV machine switch closes, and the tap changer moves to the starting position, the current in the stator winding and the induced current in the field winding causing relays to prevent further movement of the tap changer. A selector switch determines the proper stopping point of the gear. As the condenser reaches full speed and pulls into step the stator current falls to a relatively small value, whilst the induced rotor current falls to zero. The two current relays therefore drop off, and, provided that the exciter voltage has built up to the correct value, after a few seconds' delay the main field switch is closed, and the tap-changing mechanism is made to proceed continuously through all the remaining tappings to full voltage, and, finally, the automatic gear is de-energised.

WORKS TESTS.

The complete equipment has been set up in the makers' works for the purpose of an extensive series of tests. For the purpose of the starting tests a second bank of the main transformers was used to step up the power supply from 6600 volts to 44,000 volts, and current at the latter pressure was supplied to the step-down bank of the equipment under test. The torque developed by the solid pole shoes proved to leave an ample margin for all conditions. When started on the lowest tapping, which gives an input of approximately 15 per cent. of the full kVA rating, the condenser rapidly accelerated to full speed and pulled into step promptly within 1½ minutes. Oscillograms showed that the accelerating torque was fully maintained up to nearly full speed, when the rotor pulled into step without excitation. Contrary to the opinion sometimes expressed, there was no visible decrease in the torque in the region of half speed. Other oscillograms taken during the complete operation of the tap changers up to full voltage, both under manual and automatic control, showed that the currents drawn from the line were remarkably small at all stages during the starting process. Sudden short-circuit tests made on the condenser terminals at full voltage and on the 40-kV terminals of the transformer bank at over-voltage, with the 6600-volt supply disconnected, proved that the bracing of the windings was adequate. Heating tests at full kVA carried out on all three condensers by loading on

large reactors in conjunction with the wattless motor generators of the works, showed that the machines could meet the temperature rise guarantees with an ample and uniform margin on all parts; while an extensive investigation with special apparatus for power measurements at very low power factors indicated that when operating on the rated load of 20,000 kVA at 10,500 volts, the electrical input to the condenser, including all the exciter and rheostat losses and lubrication power, was only 280 kW, or 1·4 per cent. of the kVA output.

South African Engineering Notes.

(By our South African Correspondent.)

Rhodesia-Walvis Bay Railway.

FROM time to time there have been references to the proposed line to connect Walvis Bay in South-West Africa with Southern Rhodesia, and a survey has been carried through showing that its construction would present few difficulties. The project has, however, sustained a setback, owing to the Union Government having on more than one occasion shown that it is entirely unsympathetic towards it. It is not generally known, however, that there is another scheme which might easily result in a direct connection with the coast at Lobito Bay, and that is the route to the Kansanshi mines, at present owned by the Rhodesia-Katanga Company (Sir Robert Williams' group). A flying survey was made just about a year ago on behalf of Pauling and Co., and the engineer in charge pointed out that few obstacles of importance were likely, other than some heavy cutting in places. The Kansanshi mines must have a line for their output of copper. If this is built from N'Changa on the route surveyed there will be but a short length required to connect with the Lobito Bay line, and as important cobalt discoveries have been made in the Congo on the route this line would take, there is every reason to believe that the Belgians would run a line to Kansanshi, and nothing but an agreement such as exists between the copper interests and the railways could prevent all traffic going through its natural outlet. At present a journey of 2000 miles south to Cape Town by rail is necessary, whereas a journey of 1000 miles would suffice with a proper outlet to the coast. With heavy traffic the position is worse, as it must go to Beira and then round the coast. As the position is at present, the Lobito Bay route is being advertised as the one to be taken for all desiring a quick run to Europe, and it is understood that efforts are being made to speed up all traffic from Beira to help to combat the competition. This could be done by constructing the Kafue–Salisbury "cut off," but this has been condemned as an economic extravagance. It looks, however, as if the Rhodesian Railways will have to make a strenuous effort to hold the traffic and prevent direct communication with Lobito Bay, and that its only hope will be to take in hand the construction of a line to Walvis Bay sooner or later. The route is not so short, but it would have the advantage that, at all events for the present, the traffic would be kept in British territory.

Railway Workshops Busy.

Recently there has been a considerable increase in the quantity of work coming in for execution at the railway workshops, Pretoria. Some of the workshops have more than can be done in the present four-day week, and it is possible that in the near future some of the men may be placed on a five-day week basis. Coachbuilders and painters are especially busy at the present time, and in the ironfoundries as well as in some of the engineering shops a similar state of affairs is reported.

Clarification of Cape Town Water.

As a result of experimental work by the Chief Chemist of the City of Cape Town and the City Works Department, a large experimental plant, costing £6700 and capable of dealing with 300,000 gallons a day, is to be installed to clarify the water supply to Wynberg, a large suburb of Cape Town. If it proves successful the plant will be enlarged to deal with 600,000 gallons a day. Later on the whole of the supply from Table Mountain, amounting to 3,000,000 gallons a day, will be dealt with by installing a plant at Kloof Nek, and eventually a third plant will be installed at Steenbras to deal with 25,000,000 gallons a day. The water will be clarified by passing it through a tank in which it will be mixed with chemicals to precipitate certain impurities. It will next be passed through a sedimentation tank, and then through a thick bed of fine sand, emerging with all impurities removed and as clear as crystal. It is estimated that the purification of the water will eventually save property owners in Cape Town about £100,000 a year.

Union's Most Powerful Lighthouse.

The lighthouse on the Bluff at Durban is now the most powerful in South Africa, electricity having displaced oil as the illuminant after the latter had been employed there for seventy years. The candle-power of the new light is 3,000,000, compared with the 150,000 candle-power of the oil light. The change came into force in October, and during the first night's operation one vessel was able to discern the loom of the new light from the vicinity of the Aliwal shoal, 30 miles away from Durban, and to obtain cross bearings with the Green Point lighthouse, south of Umkomaas. This beam, with its range of 23 miles, is easily the most powerful in the Union, the next being at Green Point, Cape Town, 850,000 candle-power, also with a 23 miles range. Then follow Great Fish Point, 600,000 candle-power and 20 miles range; Cape Point, 500,000 candle-power, 23 miles range; and Cape Agulhas, 470,000 candle-power and 18 miles range.

Port Elizabeth Power Station.

The alterations and additions to the Port Elizabeth electricity undertaking are now completed, and the following particulars may not be without interest. The Port Elizabeth power station now contains 23,850 kW of plant, the age of which lies roughly between one and ten years. Capital expenditure on the undertaking is £862,961. The number of consumers in the area supplied is approximately 10,000. The figures in respect of 1931 show that the average evening load was 4600 kW and the average day load 5000 kW; 1·938 lb. of coal were consumed per unit generated, and 2·368 lb. per unit sent out. The average cost per unit sold was 1·346d. Coal cost 26s. 2d. per ton at the station, and the ratio of maximum demand to installed capacity was 30·60 per cent.; the load factor was 46·4 per cent.; and the efficiency of transmission and distribution, 88·7 per cent. The average cost per unit sold (1·346d.) included total costs, and interest and sinking fund capital charges. An enormous increase is taking place in the Union centres, including Port Elizabeth, in the number of houses in which not only electric lighting is installed, but also refrigerators, stoves, water heaters, electric irons, &c. This development is due to the increasing tendency of municipalities to enable domestic consumers to purchase by easy monthly payments the major electric household appliances. In Pretoria, which is, of course, one of the relatively small cities of the Union, 328 electric stoves were bought last year, and of these 131 were purchased under the loan scheme. In the Union there is a tremendous field still waiting to be exploited in this respect.

Durban's Pontoon Crane.

After a voyage of 7800 miles, the Dutch tug "Ganges" arrived in Durban on the morning of October 31st, with the 25-ton floating crane for use in the harbour there, having taken seventy-one days from the Clyde. The cost of towage was between £5000 and £6000. The tug had a crew of seventeen, and there were two watchmen on the crane, which was towed 100 yards behind the tug. The pontoon on which the crane is placed is 150ft. by 50ft. by 11ft. 6in., and is constructed on the longitudinal system to Lloyd's class for harbour service. An elm belting, 24in. deep, is fitted round the sides and ends of the hull at deck level. The propelling machinery consists of two triple-expansion engines developing a total of 200 I.H.P., giving a service speed of 5 knots. The crane has a lifting capacity of 25 tons, with a maximum working radius of 80ft.

Witbank Power Station.

The Witbank electricity undertaking, which belongs to the Electricity Supply Commission, but is operated on the Commission's behalf by the Victoria Falls Company, which takes a large block of power from Witbank to supplement the supply from its four power stations serving the Witwatersrand, comprises a power station with an installation which has now reached the big figure of 100,000 kilowatts (which is interconnected with the power supply system of the Victoria Falls and Transvaal Power Company, Ltd., on the Witwatersrand), and transmission and distribution systems radiating from the power station throughout the Witbank district. Operating as it is as a base load station, at a high load factor, principally on "duff" coal from the adjoining collieries, the Witbank power station is producing electricity under very favourable conditions, and the overall cost per unit of output ranks amongst the lowest in the world. Capital expenditure on the Witbank undertaking to December 31st, 1931, was £2,095,114. The units generated at the Witbank power station during the year 1931 totalled 643,292,677, the units sent out from the power station totalled 604,202,986, and the hourly maximum demand was 91,469 kilowatts. The load factor was 75·4 per cent. The thermal efficiency of the Witbank power station on units sent out was 16·14 per cent. As compared with the previous year, the output at Witbank decreased by 15,295,245 units, representing about 2½ per cent. This reduction is due to a combination of circumstances, affecting both turbine and boiler efficiencies; loading condition factors, and machine load factors have been less favourable, and sufficient quantities of "duff" coal have not been available, necessitating the purchase and crushing of large coal, which has affected coal grading. These various circumstances and conditions are undergoing investigation. It may be mentioned that the Electricity Commission has under consideration the linking up by means of a 88,000-volt overhead line its power stations at Colenso and Congella (Natal). No decision has yet been come to, although the reasons and advantages have been explained to the Durban City Council by the Chairman of the Electricity Commission, Dr. van der Byl.

Aircraft Problems.

ON the occasion of the Aircraft Exhibition in Paris last week the Chambre Syndicale des Industries Aéronautiques organised a series of conferences at the Aéro Club, when the papers that attracted most attention were those relating to the apparent limitations of aeroplanes and seaplanes as judged by the difficulties experienced in making them commercially successful. The phenomenal rise of aviation was attributed by Monsieur de l'Escaille, director of the aeronautical section of the Bureau Veritas, to the military importance of aircraft and to the State subsidies accorded for the development of commercial machines and for air services. If this financial assistance were withdrawn for some reason or another, such as disarmament, the outlook for aeroplane builders would be very poor indeed, unless something was done to expand the commercial possibilities of aviation. The only advantage possessed by aeroplanes over other means of transport is the saving of time, and the margin of cost between the rail and sea, on the one hand, and the air on the other, is so large as necessarily to limit traffic by air to those who are prepared to pay for an economy of time. The lowering of the cost of air transport to a paying level cannot, said Monsieur de l'Escaille, be obtained by increasing the load, on account of the rapid augmentation of weight and engine power, and he therefore argued that the solution lay in the use of light machines with a more frequent service. Monsieur Blériot objected to this conclusion, and affirmed that the excessive cost of air services was occasioned largely by an expensive organisation which was necessary to attract custom, and that for the same reason bigger machines had to be built for the comfort of passengers, who had more confidence in them than in light machines. He gave figures showing such an enormous disparity between the receipts and expenditure of a French air transport company that it seemed hopeless to expect that such a service could be made commercially successful.

There is, nevertheless, no lack of faith in the future of aviation. This depends upon the technical research work being undertaken in all countries which may lead to a further refinement in aeroplane design and to a considerable reduction in engine power, whereby it will be possible to increase the ratio of load to weight. For the moment, there is a pessimistic feeling that progress has been arrested by the high cost per ton-mile of load carried, and little more can be done until technical research allows of this cost being reduced to a point where the aeroplane can compete successfully with slower means of transport. All this refers, of course, to the conditions of continental traffic, and leaves out of the question the possibilities of developing air communication with countries overseas, where distances and difficulties of land transport give much greater importance to the time factor and may reduce considerably the disparity in cost. In the same way a paper on seaplanes by General Crocco, General Director of Research at the Italian Air Ministry, did not conceal the difficulties encountered in producing machines that have to fulfil extremely arduous conditions. He gave a particularly full account of the experimental work carried out in Italy where a tank has been constructed for testing models of seaplane hulls up to a speed of 50 miles an hour. The problem of the seaplane resolves itself into the construction of a machine that need not fly at high altitudes, but must alight at low velocity on the sea and be able to take off easily and be at the same time seaworthy. It must have a large fuel and load-carrying capacity. Hence, the seaplane is a combination of a ship and planes in which weight must be reduced without sacrificing strength. The problem is extremely complex, and has not been solved by any particular type of machine, and General Crocco illustrated five different types built in Italy, from flying boats with stabilisers attached to the hull to machines with floats arranged in different ways. He said that each type of boat fulfilled particular conditions, so that no one type could be regarded as better than another. The conclusion come to is that experimental data can alone provide the basis of theory in seaplane design, and that a vast amount of investigation has still to be carried out before there can be any prospect of evolving satisfactory machines for ocean service. The weight of such machines is the chief obstacle to progress at the moment.

The last discussion was opened by Mr. Pye, Deputy Director of Scientific Research at the Air Ministry, who surveyed the work that had been done to solve the many problems of air engine design and construction, and explained the difficulties by saying that the engine was a compromise in which any new improvement was effected at the expense of something else. His reserved attitude towards the solid injection air engine called forth opinions, in the discussion that followed, which showed the French to be entirely optimistic as regards the final solution of the problem, primarily as the result of tests that have been carried out with the radial cylinder engine upon which Monsieur Clerget has been at work for the French Air Ministry for many years past.

The Smithfield Club Show.

ONE of the most striking impressions which one gains on visiting the Royal Agricultural Hall, where the Smithfield Club Show is being held this week, is that the supersession of the horse by the oil tractor for farming purposes has coincided with a most severe depression in many of the engineering firms which for generations past have relied on their trade in agricultural machinery. This state of affairs is no doubt largely to be attributed to the loss of our foreign markets, and is accentuated by the consequent collapse of Agricultural and General Engineers. This year there is not one steam engine in the whole Show, neither are there any of the big oil-driven ploughing outfits which have become familiar of recent years. There is not a wagon or a thrashing machine in the whole hall. So it will be appreciated that a number of old friends who have patronised the Show from time immemorial are not represented, and we could find few of them among the visitors. In the circumstances, we do not propose to mention any names, as it would seem like calling over the roll to see who is absent.

On the other hand, there is a considerable number of oil-driven tractors, all of which have a distinctly American appearance, although they may be made in England. These machines remind one of the "scraggy" outline of an American locomotive, as compared with a British engine. There is no doubt, however, that they do the work for which they are intended, and that under very adverse circumstances. Another thing which we noticed was the advent of the pneumatic tires for agricultural vehicles, a development to which we have previously referred. There are a few stands on which oil and petrol engines are displayed, but these are all of comparatively small size, the largest we noticed being of 4 horse-power. It may be that the absence of larger oil engines is due to the impression that the gradual development of the "grid" may make such engines unnecessary; but, on the other hand, there is no great indication of manufacturers of farming machinery taking steps to utilise a general supply of electricity. In fact, electrically driven machinery is conspicuous by its absence.

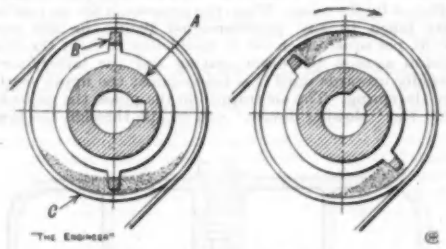
There is, however, one most ingenious and novel machine up in the gallery. It is used for planting out seedlings, and takes the place of hand dibbling. On a carriage, which is drawn by a tractor, there is a small plough for cutting a furrow to receive the plants. Down the centre of the machine there run two chains, which are fitted with hinged arms. These arms are spread out horizontally as they travel forward and are supported on runways. On either side of the ways there are two seats, for boys, who place the plants in grips on the ends of the

arms. Arriving at the front end of the ways, the arms fall over and hang vertically with the root in the furrow. The grips then release them and two wheels press the soil round the plants. The arms then go on to the top again to be recharged. It is claimed that this machine will put in 12,000 plants an hour.

To make up for the absence of much heavy engineering work, there is an unusually extensive display of agricultural implements. These are, of course, engineers' products, in the true sense of the term, but their chief interest to engineers lies in the mode of production and the description of processes is not appropriate here. There are also good displays of milking and refrigerating machinery. The Exhibition closes to-day.

The Pulvis Clutch.

WE learnt during the past week that the British Rema Manufacturing Company, Ltd., of Halifax, had taken up the manufacture of a new clutch. The operation of the new clutch—known as the Pulvis—is illustrated diagrammatically by the accompanying engraving. The impeller A has a circumferential slot bridged at two points diametrically opposite one another by blades B. It is keyed on to the driving shaft and rotates within a housing C in the end covers of which there are bearings to support it. The housing is the driven member of the clutch, and externally may take any suitable form, such as, say, a belt or texrope pulley, or, alternatively, it may merely be connected to the driven shaft. Internally, it has a number of serrations cut in the metal in an axial direction. A small amount of shot of small diameter is introduced

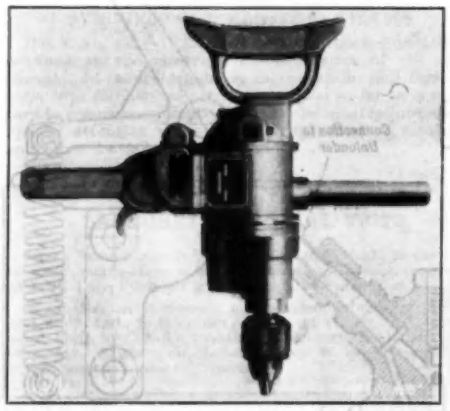


OPERATION OF PULVIS CLUTCH

within the housing through a hole, which is subsequently plugged. The left-hand sketch shows the clutch at rest and the shot is at the bottom. When the driving shaft starts to rotate, the impeller A ploughs its way through the shot, which is able to pass along the circumferential slot and under the blades which bridge it, until, as the speed increases, the housing begins to rotate. As the speed increases, the shot packs in front of the blades and transmits the drive without slip—see right-hand sketch. If, for some reason, the clutch becomes overloaded, part of the shot continually "leaks" past the blades and, consequently, slip occurs. By varying the amount of shot the starting period before the housing reaches the speed of the driving shaft can be fixed at any interval between a few seconds and several minutes. It is claimed that the clutch suffers no wear.

Electric Tools.

DURING a recent visit to the showrooms of Newtons of Taunton, Ltd. (the garage equipment section of Lucas-C.A.V.-Rotax), at 319, Regent-street, W., we were shown a collection of electric tools made at the Willesden works



PORTABLE ELECTRIC DRILL

of the Lucas organisation. For the most part electric tools that have hitherto been sold in this country have been imported, but those under consideration are entirely British. The makers claim to have exceptional facilities for their production and to be capable of turning out drills, &c., superior to those made abroad. At present the range comprises electric drills as shown in the accompanying illustration, electric valve refacers, and engine tool kits for de-carbonising, &c.; but in the near future other electrically operated tools will be available, such as sanders, bench and portable grinders, and polishers, &c. The ⅜in. and ¼in. drills that were shown to us were of massive construction, yet of neat and handy design and, as shown in the illustration, the trigger safety switch is placed in an accessible position. Immediately the switch is released the current is interrupted, but a special locking device enables the switch to be held in the "on" position when the tool is mounted on a Rotax bench drill stand, supplied for converting a portable tool into a bench tool.

The distinguishing characteristics to which the makers direct attention are that the dynamically balanced armatures associated with all the tools have hand-wound former coils, the field coils are wound with enamelled and silk-covered wire, all gears and other highly stressed parts are of nickel-chrome steel, and the housings are composed of a special aluminium alloy. The safety switch to which we have alluded is claimed to be the best so far designed. The "Rotax" valve refacer handles valves used on private car, lorry, and many aircraft and motor boat engines, the range of the valve stems that can be held in the machine varying from ¼in. to ⅝in. diameter. There are two small electric motors, one of which drives the grinding wheel by means of a belt, whilst the other drives the work head, which is arranged to swivel from 15 deg. to 90 deg. measured on a graduated scale.

Crane Safe Load Indicator.

SINCE it was enacted that all cranes must be fitted with a safe load indicator, a number of different designs have been put on the market. Brown and Aitken, of 46, Victoria-street, London, have brought to our notice the one illustrated by the two accompanying engravings. The photograph reproduced in Fig. 1 shows the indicating mechanism within its box, the cover of which has been removed without disturbing the mechanism, while the line engraving Fig. 2 illustrates the principle on which it works. The indicator is inserted in the derrick rope, and it will be seen from the engravings that even if breakage of the mechanism should occur the safety of the crane is not endangered. Referring to the engravings, it will be seen that the anchorage cable is connected to the short arm of

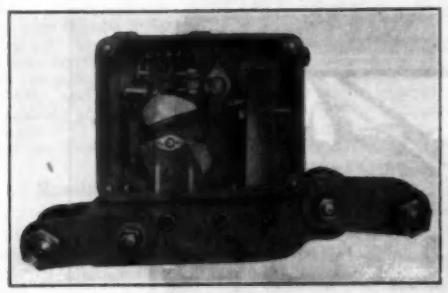


FIG. 1—CRANE SAFE LOAD INDICATOR

a bell crank lever A, the longer arm of which projects into the indicator box and carries a pulley wheel at its end. A stout steel cable encircles the pulley, the ends being taken around a "radius" piece B and firmly clamped. The "radius" piece is able to rotate, but its centre of rotation is nearer one end than the other, so that the tensions in the two cables acting upon it to rotate it exert a differential moment around the centre of rotation. This small differential moment is balanced by a small spring C acting upon the end of a long arm D. Thus the heavy load on the derrick rope is converted, for the purposes of measurement, into a light load on a small spring. The arm D to which the spring is attached carries an electrical contact on a bracket. As the load on the derrick rope of the crane increases the arm rises until the contact completes an electrical circuit by touching a contact on a free-swinging arm, Fig. 1. Completion of the electrical circuit operates a warning device in the crane driver's cab. To

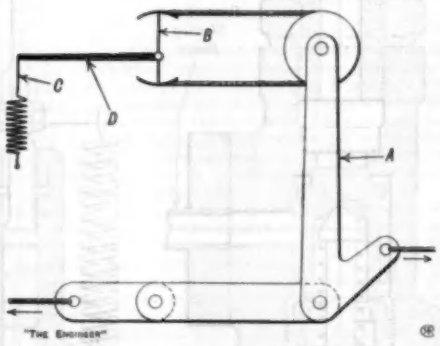
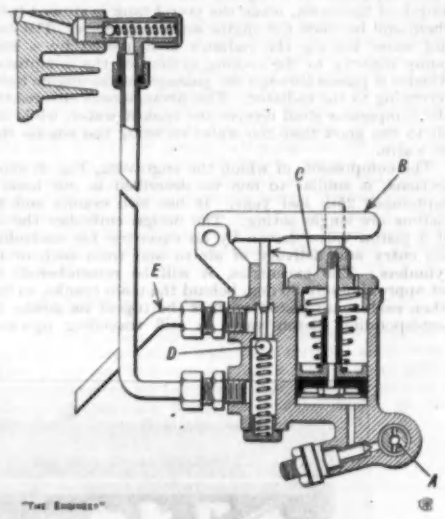


FIG. 2—PRINCIPLE OF OPERATION

allow for the different radii at which the jib of the crane may be acting and the consequent increase or decrease of the safe load the second electrical contact, as already mentioned, is mounted on a free-swinging arm. This arm is supported by a cam mounted in frictionless bearings and maintained in position by a heavy pendulum weight, the position of which relative to the mechanism alters according to the angular position of the derrick rope of the crane. It is interesting to note that the mechanism can be completely dismantled while in position in the derrick rope and that, being covered in, it is not likely to suffer damage during the erection of the crane. No structural alterations to the crane are required to insert it. On steam-driven cranes a pointer can be fitted to give the indication against the outside of the box instead of the electrical mechanism. The actual load measured is only about one five-hundredth part of the load on the derrick rope.

The Oilmatic Safety Release.

THE accompanying line engraving is a sectional view of the new "Oilmatic" safety release recently put on the market by B.E.N. Patents, Ltd., of 92, Tottenham Court-road, London. It is designed to unload compressors and to hold them unloaded when stationary and until full-speed running is attained. It consists of a spring-loaded piston capable of being forced up the cylinder by oil from the lubricating system of the compressor. The oil enters by a small passage A and the rate at which it can flow into the cylinder is controlled by an adjustable needle valve. The lifting of the piston under the influence of the oil pressure raises an external lever B, which is connected at a point nearer its fulcrum with a rod C projecting from a second chamber. When this rod is



OILMATIC SAFETY RELEASE

raised it allows a ball D to rise against a seating under the influence of spring pressure. The small chamber below the ball valve is in communication with the cylinder of the compressor. While the ball is off its seat air from the compressor can blow straight through to atmosphere through the pipe E, but when the ball seats the compressor is put on load and the air pressure helps to maintain the ball against its seat. On shutting down the compressor the oil pressure fails, the piston falls, and the ball valve is forced off its seat by the rod, so that the compressor is unloaded. Should the oil pressure fail for any other reason, the same sequence occurs. It is necessary to maintain the pressure within the secondary chamber of the device on the suction stroke of the compressor, and this object is effected by fitting another small, lightly spring-loaded valve at the junction between the cylinder head and the pipe line to the device.

The Quead Mechanical Hammer.

USERS of wall plugs have all at some time or another, no doubt, found considerable difficulty in "jumping" the necessary hole in a wall with a hand hammer; and even those who find no difficulty would, we feel sure, welcome any device which relieved them of a somewhat slow and tedious task. The Quead mechanical hammer, which has recently been put on the market by William Geipel, Ltd., of Vulcan Works, Bermondsey, is designed to do mechanically what heretofore has been done by hand. The hammer is an ingenious combination of a hand drill and a hammer head. On turning the handle a worm raises and releases the hammer head, which is forced downwards again by a strong spring giving a series of regular and uniform blows at a high striking rate. At the same time the bit is rotated. The hammer is suitable for drilling holes for standard wall plug sizes 3, 6, 8, and 10; weighs 14 oz. and is 9½in. long.

WELSH bunker coals at lower rates and in quicker time can now be secured at Genoa than has been possible in the past. A floating depot in the form of a ship with a capacity of 15,000 tons has been anchored in the harbour. Vessels can berth by day or night on either side of the floating depot, which is equipped with electric cranes capable of loading at the rate of 140 tons an hour, so that ship's winches are not necessary for bunkering. The depot is also fitted with windlass and other mechanical appliances for the rapid mooring and unmooring of vessels.

THE first commercial use of selenium stainless steel was in connection with a free-machining 18-8 steel known in America as "Carpenter Stainless Steel No. 8," which contains approximately 18 per cent. chromium, 9 per cent. nickel, and 0·25 per cent. selenium. When this 18-8 free-machining steel was first announced by the Carpenter Steel Company a few months ago, it contained about 0·30 per cent. sulphur as the free-cutting agent. The sulphur has now been replaced by selenium, with considerably improved results. Experiments indicate that the free-machining qualities are proportional to the total selenium content. The finished product is much tougher and has less tendency to transverse fracture. In transverse tests, selenium steels have about one-third greater elongation and reduction of area and twice the Izod impact resistance of the sulphur stainless steels. The ultimate strength is the same.

A Compact Portable Compressor.

WE recently had the opportunity to inspect in the works of Reavell and Co., Ltd., at Ipswich, a very compact portable compressor set made by the firm to meet an order for twelve such sets for the Director of Army Contracts. While the compressor is capable of delivering 100 cubic feet of free air per minute compressed to a pressure of 100 lb. per square inch, the overall dimensions of the set are only 6ft. 6¼in. long by 2ft. 8in. wide by 4ft. 4in. high, and its weight just 22 cwt. As will be seen from the engraving, Fig. 1, the compressor itself is mounted upon the truck at the end remote from that carrying the radiator. It is driven by a Climax petrol engine, developing 32½ B.H.P. at 1200 r.p.m. through a centrifugal clutch, which relieves the engine of the compressor load for starting. Two air receivers are slung above the compressor and engine, and extend almost the full length of the truck, while the petrol tank is stowed below them and between the engine and compressor. The cooling water leaving the radiator is delivered by a small pump directly to the cooling system of the compressor, whence it passes through the passages of the engine before returning to the radiator. This arrangement ensures that the compressor shall receive the coolest water, while it is all to the good that the water entering the engine shall be warm.

The compressor, of which the engraving, Fig. 2, shows sections, is similar to one we described in our issue of September 25th last year. It has two cranks and the pistons are single acting. The design embodies the use of a piston valve driven by an excentric for controlling the entry and delivery of air to and from each of the cylinders. The excentrics, it will be remembered, are set approximately 90 deg. behind the main cranks, so that when each main piston reaches the top of its stroke the corresponding piston valve is still travelling upwards,

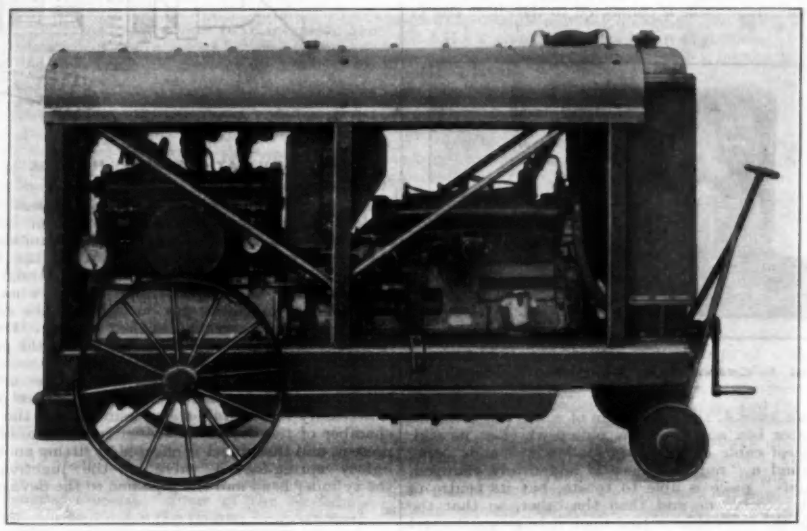


FIG. 1—PORTABLE AIR COMPRESSOR

and has just reached the "cut off" point. Part of the compressed air which is trapped between the top of the piston valve and the ordinary Reavell compressor spring-controlled valve is delivered by the movement of the piston valve. Owing to the relatively slow motion of this valve the spring controlled valve seats gently and silently when delivery is complete. The design also has the advantage that the whole of the cylinder head may be water-cooled.

The chief modification introduced since last year is the ingenious unloading device illustrated in more detail in Fig. 3, which is built into the casting between the cylinders. It was, we understand, invented by Mr. William Reavell himself, and patents have been applied for. Connecting together the two cylinders there is a passage which may be blocked by a small spring-controlled piston. When unloading becomes necessary, a relay operated by the air pressure within the receiver admits air to the chamber above the piston which is forced downwards, so that the two cylinders are interconnected. The air is then passed back and forth from one cylinder to the other as the main pistons rise and fall.

The air relay already mentioned is illustrated on the left of the line engraving, Fig. 4. It consists of a specially shaped piston able to seat itself accurately against a facing at top and bottom, and capable of a short vertical motion. Normally, it is held against the top seating by a spindle and a spring, the compression of which is adjustable. The pressure of the air within the receiver acts upon the exposed top surface of the piston, and when it reaches a predetermined degree of intensity—in this case, 100 lb. per square inch—the piston is forced downwards. So soon as it leaves its seating the entering air is able to act upon a greater area, with the consequence that the piston is driven rapidly downwards and held against the lower seating. There is a clearance between the piston and the walls of the chamber in which it moves and through this space the air flows into a pipe which directs it to the "slowing device" mounted close to the carburetter of the engine. The drawing on the right-hand side of the engraving, Fig. 4, shows the "slowing device." Air from the relay enters it from below and may find its way unimpeded into a small chamber below a plunger which is lifted against the restraint of an external spring and operates the throttle of the engine through a bell crank lever and a rod. The speed of revolution is reduced thereby to about two-thirds of normal. At the same time the air entering the device may also find an outlet by lifting a ball valve and passing through another small bore pipe, to the unloader, the operation of which has already been explained.

Easing down the engine and unloading the compressor should take place simultaneously, but it is essential when reversing the process that the speed of revolution of the engine shall be increased and its throttle opened before the compressor is again loaded. If precautions are not taken to ensure this sequence, the engine may "stall." The "slowing device" is so designed that the interval between the moment when the engine throttle is opened and the time at which the compressor is reloaded may be adjusted to any suitable amount. In order that the throttle shall open and the unloader come out of action, the air must be allowed to leave the system and the release is effected by the relay. When the pressure in the air receiver has fallen to any predetermined figure—in this case, 80 lb. per square inch—it is insufficient to hold the relay piston against the lower seating and the latter moves rapidly upwards until it is held against the upper seating by the spring. The air trapped in the pipes, the unloader, and the "slowing device," can escape through the lower seating and the clearance around the spindle. No impediment is offered to its flow from the chamber beneath the plunger in the slowing device, so that the throttle of the engine is at once opened. But the release of the pressure causes the ball valve in the passage leading to the unloader to return to its seat, so that the air within the unloader can only escape through a by-pass passage and an adjustable conical valve. Reloading of the compressor is consequently delayed, while the time lag can be suitably adjusted.

We had the opportunity of observing these controls in

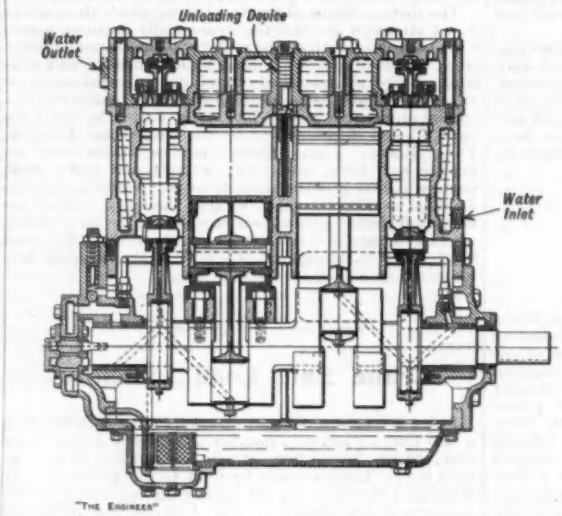


FIG. 2—SECTIONS THROUGH COMPRESSOR

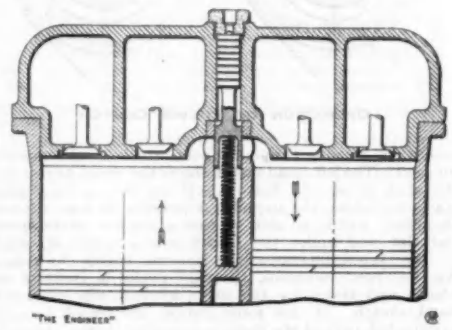


FIG. 3—UNLOADING VALVE

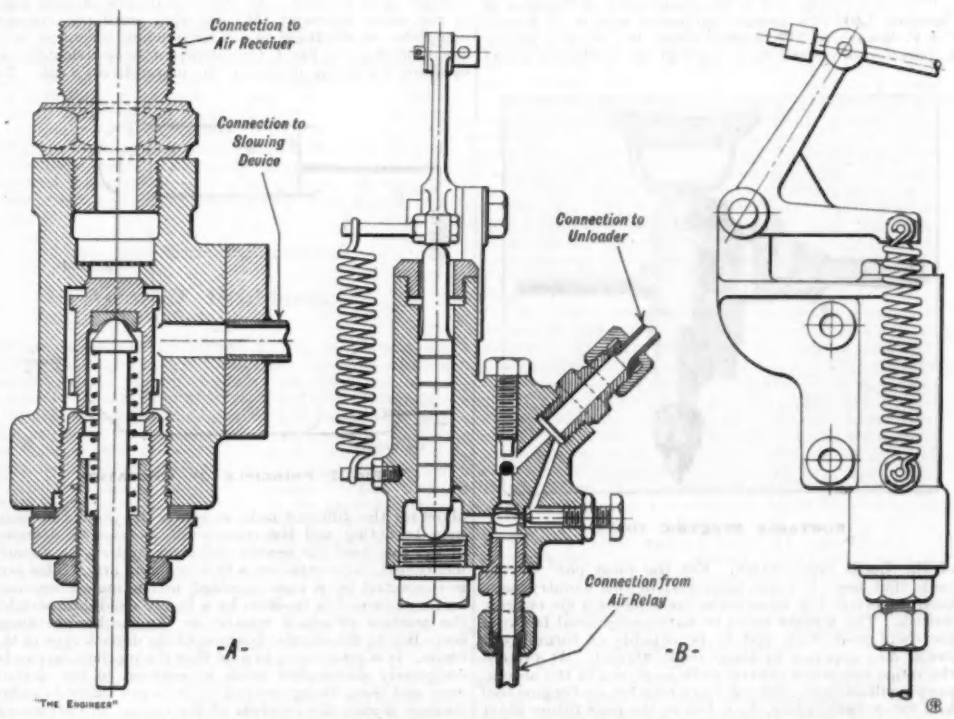


FIG. 4—AIR RELAY AND SLOWING DEVICE

action, and although the compressor set had been standing idle out of doors sufficiently long to be quite cold, and was given less than five minutes in which to "warm up," we observed that the engine had no difficulty in "picking up" the load. A small amount of air was allowed to leak continuously away from the receiver, with the result that the set loaded at 80 lb. per square inch and unloaded at 100 lb. per square inch as regularly as a clock ticks out the minutes and with the same absence of fuss. The engine showed itself to be easily started and the centrifugal clutch took up and transmitted the load without shock. The whole set impressed us as a sturdily constructed, remarkably compact, and neatly finished piece of engineering.

SHARING WORK.

REPORTING that in a single month 500,000 American workers have been taken off the unemployed register of the Department of Labour at Washington, a New York correspondent forwards particulars of a nation-wide movement to distribute the available work among a larger number of those usually engaged in the various industries.

The engineering and associated trades, he writes, have participated wholeheartedly in the scheme, and it is officially recorded that of 980 firms in that category, 85 per cent. have adopted and applied the "share the work" principle. In the majority of cases the method has been to change the time schedule as a whole, basing the new one on either a reduced working week or day, while many others instituted a system under which workpeople took a day or a week off, allowing others who were unemployed to take their place, and have at least part-time employment.

Details of the methods adopted in some instances will interest industrialists in this and other European countries.

A machine shop and foundry that was hard hit by the depression agreed to share the work available among the whole of their employees, pay being allowed in proportion to the hours worked. One week they found the orders in hand allowed six hours to be allotted to everyone on Monday. Then a slump followed, and on Tuesday, Wednesday and Thursday four hours each day was estimated to be sufficient. Additional orders being then to hand, a five-hour day was ordered. The rule was applied to everyone on the pay-roll, with the result that the whole of the employees are making half-time, instead of part of them receiving full employment and the remainder being turned off. The employees recognise that this is a fair deal, while the firm avoids the loss of efficient and skilled workers.

A Wisconsin heavy engine factory originally working nine hours a day for 5½ days each week, reduced their schedule to eight hours per day for the same number of days. Facing a further decline in volume of business, the firm decided to close down altogether on Fridays and Saturdays, providing a thirty-two-hour week for all instead of discharging a portion of their staff.

The "share-the-work" movement was inaugurated by the President, after Mr. Hoover had convened a conference of leading bankers and employers, and there are now committees of those two classes operating to get the principle applied in each of the big centres of industry from East to West of the Continent. In all 5000 companies have reported on their experiences, and Mr. William Green, President of the American Federation of Labour, has declared the application of the principle "should be supported by employers and employed."

BRITISH STANDARDS INSTITUTION.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W. 1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

SYNCHRONOUS ELECTRIC CLOCKS.

B.S.S. No. 472—1932. The scope of this specification is confined to the electrical characteristics of the clock essential to ensure reliability in operation, and does not enter into mechanical details, except in so far as is necessary to ensure compliance with the electrical requirements. Special attention is paid to the question of insulation and other features affecting safety.

LAUNCHES AND TRIAL TRIPS.

LIGHT VESSEL; built by A. and J. Inglis, Ltd., to the order of the Commissioners of the Northern Lighthouses, for service at North Carr, Firth of Forth; launch, December 2nd.

WANGANELLA, twin-screw motor vessel; built by Harland and Wolff, Ltd., to the order of Huddart Parker, Ltd.; dimensions, 479ft. by 63ft. 6in. by 34ft. 6in.; to carry mails, passengers and cargo. Engines, oil, Harland-B. and W. type; constructed by the builders; trial trip, recently.

CORRECTION.—In the article on the "Mayfair Automatic Telephone Exchange," appearing in our issue of November 18th, it was stated that the motor generators, ringing machines and switchboard were supplied by the G.E.C. We are informed, however, that the machines were built by the E.C.C. (the Electrical Construction Company, Ltd.), whilst Automatic Electric Company, Ltd., supplied the switchboard.

THE PHYSICAL SOCIETY'S EXHIBITION.—The twenty-third annual exhibition of scientific instruments and apparatus, arranged by the Physical Society, will be held on January 3rd, 4th, and 5th, 1933, at the Imperial College of Science and Technology, Imperial Institute-road, South Kensington, S.W.7. It will be open in the afternoons from 3 p.m. to 6 p.m., and again in the evenings from 7 p.m. to 10 p.m. Discourses will be delivered each day at 8 p.m., as follows:—January 3rd, Dr. Allan Ferguson, M.A., F. Inst. P., "Surface Tension and its Measurement" (illustrated by experiments); January 4th, Mr. R. A. Watson Watt, B.Sc., A.M.I.E.E., F. Inst. P., "Cathode Ray Oscillography" (illustrated by experiments); January 5th, Mr. F. Hope-Jones, M.I.E.E., F.R.A.S., "Time Measurement: Old and New" (illustrated by experiments).

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Trade Situation.

THERE has been no alteration on the week in the industrial position in the Midlands and Staffordshire, neither have there been any developments of note in the iron and steel market. While the prevailing tone is one of hope, the forward movement is very gradual. The position is materially better than it was at the opening of the quarter, and it is believed there will be some carry-over of business to the New Year. A number of contracts have been made running into the first quarter of 1933, but, generally speaking, buyers are exercising considerable caution as to forward supplies. The volume of business in iron and steel transacted this week was on a moderate scale, but it related almost entirely to British material. District firms are benefiting from the subduing of foreign competition, and demand is expected to develop further.

Production of Basic Bessemer Steel.

The decision of Stewarts and Lloyds, Ltd., to manufacture basic Bessemer steel in this country is an important development towards making the steel industry thoroughly efficient and self-contained. Production once again in the Midlands of this class of steel will be welcomed, as being an addition to the existing steel resources of the area. It is worthy of note that one of the last firms to produce basic Bessemer steel in this country in the past was Alfred Hickman, of Bilston, and it is appropriate, therefore, that the revival of the manufacture of this steel should take place in the Midlands. The new plant, which is to be put down at Corby, in Northamptonshire, will be in the midst of the biggest iron ore field in the country, an area stretching northwards from Oxfordshire across Northamptonshire, and taking in Rutlandshire and parts of Leicestershire. The potential supply of ironstone is large enough to last much longer ahead than any of us can see. Stewarts and Lloyds have a substantial share of these supplies directly at their command. A subsidiary of the company carries on a battery of blast-furnaces at Corby, and a few years ago another Northamptonshire smelting plant near Kettering was acquired. The ironstone of the district possesses properties which fit it well for the Bessemer basic process.

Manufactured Iron.

Although quiet conditions prevail in the finished iron industry in Staffordshire, there are signs that the sluggish stream of trade is quickening. Over the last week business, though still unsatisfactory, has been rather better and output at some of the local works has been slightly heavier. At a number of the mills, rolling programmes are becoming more regular, as specifications against standing contracts improve. As has been the case for a long while now, chief activity is to be found at the marked bar mills. In many branches of engineering, best quality bars are almost an essential. Staffordshire makers have no difficulty in obtaining their quoted selling price of £12 per ton for their output. What they require is the opportunity to increase production, and so bring down costs. Producers of crown quality bars have still to compete with makers from other districts for the very limited business which comes on to the market. In this they are only partially successful as their selling figure of round about £9 10s. is in advance of that of their rivals. Nut and bolt and fencing bar iron is in a little better demand, the consuming industries having picked up a little during the past week or so. Also a number of small orders are being taken by local manufacturers at the expense of the foreigner. Nut and bolt bars of Staffordshire make are still quoted £8 per ton, and fencing iron £7 15s. The situation is unchanged in the strip department. Requirements are moderate and selling values firm. Wrought iron gas tube strip is quoted £10 7s. 6d. to £10 10s. per ton delivered.

Steel.

In the steel market that branch relating to the supply of finished material lacks life, while the half-products department continues to gain strength. None of the heavy engineering industries in this area are well blessed with orders, and even the fortunate firms do not call for heavy tonnages of steel. Their consumptive requirements are considerably below normal, the orders on their books referring to small work. Steelmasters hold to the Association selling figures of £8 7s. 6d. for angles, £9 7s. 6d. for tees, £8 15s. for joists, and £8 17s. 6d. for ship, bridge, and tank plates. These figures are all subject to special rebates to those who confine their purchases to British material. Boiler plates are quoted £8 7s. 6d. to £8 10s. per ton. Manufacturers of steel semis in this district are making better sales of small bars and of billets as a result of the changed conditions on the Continent. The price of foreign small steel bars, sheet bars, and billets is too high to permit of their sale in this market, and district mills are getting some of the business which for a long time past has been placed with Continental firms. If current prices of Continental material persist, there is every prospect of the orders which mature coming to local steelmasters. As yet demands made upon local steelmasters have increased only slowly, but they will grow as consumers use up their stocks of foreign steel. Staffordshire re-rollers maintain their quotation of £6 15s. for small steel bars re-rolled from foreign raw material, and of £7 for all-British bars. Mild steel billets range in value from £4 17s. 6d. to £5 7s. 6d., while sheet bars make £4 15s. upwards. The improved demand, recently recorded, for steel strip and special steels is maintained, and further progress towards satisfactory conditions is reported in the scrap market. Current inquiries lead to hopes of good business in the near future.

Raw Iron.

There is no change on the week in the pig iron industry. Output alike in Northamptonshire and in Derbyshire is in excess of the requirements of the market. The surplus is, however, becoming smaller every week, and for this blast-furnacemen are thankful. The quantity of foundry iron taken by makers of light castings is rather better than in the early autumn, but little material is being dispatched to general engineering foundries. Northamptonshire smelters are still disposing of some of their output in Northern markets, where they are free to ask what price they like for their iron. For delivery in the Midland zone, sales are made at the rates laid down by the Central Pig Iron Producers' Association. These are:—Derbyshire No. 3 foundry, £3 6s.; forge, £3 1s.; Northamptonshire No. 3 foundry, £3 2s. 6d.; forge, £2 17s. 6d.—all per ton and subject to rebate to buyers of large quantities.

Galvanised Sheets.

Galvanised sheet mills in this district continue under-employed, and activity in the market remains rather slow. Orders for overseas are received day by day, but unfortunately they relate mostly to small quantities. There is no alteration in the volume of demand in the home trade, and it is reported that buyers have not taken kindly to the new selling arrangements. No revision of prices has occurred since my last letter, and quotations for 24-gauge corrugateds are £10 per ton for export and £11 5s. to £13 5s., according to tonnage, for the home trade. Demand for and prices of lighter gauges are likewise unaltered. Consumption of black sheets grows steadily, and activity at the automobile works inclines one to the view that the improvement will be maintained. Selling prices to the home trade are £9 5s. for 10-ton lots, with a rising scale for smaller tonnages. The export quotation is £8 5s. f.o.b.

£26,000 Order for West Bromwich.

An order for thirty new bogie trucks for the Liverpool Corporation tramways service, at a cost of £895 a car set, and representing a total cost of £26,850, is recommended by the Committee to be placed with the Electro-Mechanical Brake Company, Ltd., of West Bromwich.

Cannock Chase Coalfield.

The reorganisation of the Cannock Chase coalfield by means of amalgamation, at the instance of the Coal Mines Reorganisation Commission, referred to in my letter last week, is providing the most important subject of discussion in mining circles here. The mineowners are apparently fearful of the consequences, and, with one exception, they are opposed to the project. A point specially stressed is that in any scheme of amalgamation there would be destroyed that valuable asset of close contact between masters and men which has for many years been a notable feature of the local mining industry. It is no secret that the coalowners resent the compulsion that is being applied, being of the firm opinion that no possible good can come from amalgamation; indeed, they forecast damaging results to the industry if the decisions of the Commission are enforced.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Public Works Expenditure.

THE virtual cessation of expenditure on new public works schemes has had a serious influence on employment conditions in Lancashire and Cheshire. It has, for example, brought many constructional engineering concerns almost to a standstill, and the remainder, with a few exceptions, are only moderately busy. In the Lancashire county area twenty-eight road and bridge improvement schemes have been either postponed or curtailed, the deferred expenditure being estimated at £1,250,000, whilst in Cheshire approved works costing £1,605,254 are to be deferred for two years. The matter has been considered at a conference at Preston of Lancashire County and non-County Boroughs, and a deputation was appointed to interview the Ministers of Labour and Health. The conference passed a resolution urging the Government to relax the restrictions now in operation that prevent the carrying out of unemployment relief schemes which local authorities are willing to proceed with. Sir Max Muspratt, the chairman of the Finance Committee of the Liverpool City Council, stated that Liverpool had spent £2,000,000 on unemployment relief works, and was prepared to spend another £2,000,000 if the Government would give adequate assistance. If they could not have the big schemes, he suggested that schemes should be undertaken which would chiefly employ skilled labour, for, he said, it was the skilled worker who was the chief sufferer at present.

£700,000 Extension Scheme Postponed.

The Town Hall Extension Committee of the Manchester City Council has decided to defer the question of proceeding with the Town Hall extension scheme for three months. Meanwhile, a report is to be submitted with regard to the financial position. The scheme is expected to cost between £600,000 and £700,000, and has been held up in consequence of the economic position.

Railway Axle Plant for Russia.

An order which Craven Brothers (Manchester), Ltd., machine tool makers, of Vauxhall Works, Reddish, near Stockport, have received from Russia for a railway axle plant capable of producing about 270,000 railway axles a year has come at a welcome time. According to a statement made by an official of the company, the firm has just completed a big contract, and in the absence of other important work it would have been necessary to dispense with a considerable number of employees. It is understood that the Russian order in question will ensure continuity of employment for a large number of foundry and machine tool workers for at least six months.

"Grid's" Largest Transformers.

One of the two transformers for the sub-station of the Central Electricity Board adjoining the Liverpool Corporation's new Clarence Dock power station has been completed at the Hollinwood, near Manchester, works of Ferranti, Ltd., and was transported by special train from Manchester to Liverpool by the London, Midland and Scottish Railway Company last Friday. The transformers are 25 per cent. larger than any other transformers on the "grid" system, and, as self-cooled units, will, it is said, be the largest in the world. Each of the transformers, with its cooling equipment, weighs about 100 tons. Under normal conditions the capacity is equal to about 100,000 H.P. each.

Non-ferrous Metals.

Conditions on the non-ferrous metals market during the past week have been of a mixed character, and, on balance, price changes are irregular. The trade demand for copper has been at a very low ebb and speculative activity, also, has been smaller than usual. War debts uncertainties and the conference of copper producers now proceeding in America have been retarding influences in this section, and, under the circumstances, a decline in the quotations for standard brands of copper ranging from about 27s. 6d. to 30s. per ton will not be surprising. Tin, also, has had considerable ups and downs, but in this case the trading position has been slightly less depressed and the supplies are less top-heavy than with copper. In this section, values moved up after earlier setbacks and at the moment of writing are higher by about £1 5s. per ton than they were a week ago. The demand for lead during the past week has been no more than moderate, and at times speculative selling of the metal has been much in evidence. Relatively, spelter has experienced the most active conditions, although these occasions during the past week have alternated with quiet spells. Prices, however, have been well held and have finished up at 5s. per ton above those current a week ago.

Iron and Steel.

The imminence of stock-taking operations in many of the iron and steel-using works in the district and the approach of the Christmas and New Year holidays have had their effect on new business, and slow conditions have been experienced on the Lancashire iron and steel markets this week. Apart from these seasonal influences, however, the foundries, except in a few specialised sections, are badly situated from the point of view of order books, and this week no more than hand-to-mouth orders have been placed. Values are maintained on the basis of 67s. per ton, delivered in the Manchester district, for Staffordshire and Derbyshire No. 3 iron; 65s. 6d. for Northamptonshire; 62s. for Derbyshire forge, and about 83s. 6d. for Scottish foundry. The demand for finished iron locally is on a restricted scale, but quotations are held at late rates. Some forge masters, although handling less inquiry than was the case a few weeks ago, are moderately busy for the time of the year. In the steel trade, constructional engineers in particular, but other branches of the heavy consuming industries as well, are taking only limited quantities of steel materials, and there is little prospect of any improvement before early in January. Small re-rolled bars are quoted at about £7 per ton, with sections at £8 7s. 6d., joists at £8 15s., ship and tank plates at £8 17s. 6d., boiler plates at about £8 10s., and large diameter bars at £9 7s. 6d.

Obituary.

The death occurred last week of Mr. William Henry Vaughan, head of the Vaughan Crane Company, Ltd., Openshaw, Manchester.

BARROW-IN-FURNESS.

Hematites.

The market for West Coast hematite pig iron has so far improved that on Saturday last two furnaces were put into blast at the Barrow Ironworks, which had been idle since last August owing to the slackness of trade and the heavy stocks of iron held. The demand is mostly on general home account, and now Barrow steel makers are coming in for supplies. Continental business is very dull. With these two furnaces operating at Barrow the output is still very far from the normal.

Iron Ore.

There is a fuller demand for iron ore and more activity at some of the mines. The Newton Iron Ore Mine near Barrow is at work again. The importations of foreign ore are very quiet.

Steel.

The position in the steel trade has improved. For many weeks only the hoop mills have been engaged at Barrow, but the main plant has now been put on for the rolling of steel rails, &c. The demand for rails, however, is still very quiet on both home and overseas account.

Shipbuilding.

Vickers-Armstrongs, Ltd., are in receipt of an order from the Portuguese Government for two submarines.

SHEFFIELD.

(From our own Correspondent.)

Steel Trade Prospects.

A SUBSTANTIAL expansion of business in the New Year is anticipated in the heavy steel branches. Though firms are not inundated with orders, they are receiving numerous inquiries, some of which, they expect, will lead to tangible results. Confidence in the ability of the heavy trades to restore their equilibrium is greater than it has been for a long time, and if the war debts question does not have a retarding effect, Sheffield's basic industries should enter upon an era of greatly improved conditions ere long. At the same time, trade is better now than recently, but prices seem to be the chief factor. With the virtual disappearance of foreign competition, due to legislative reasons, competition among the home producers is more intensive, with the result that much of the work accepted scarcely covers the cost of production.

Steel Production.

The general improved position in steel may be judged from the fact that the Park Gate Company, where six furnaces are operating, may soon put an additional furnace into operation, whilst the English Steel Corporation's works are fairly busy, and Hadfield's have more work on hand. Considerable special steel work is being done by the Daniel Doncaster section of the United Steel Companies, and it is anticipated that a third furnace will soon be put into commission at the Stocksbridge works of Samuel Fox and Co. The rolling mill departments of Brown, Bayleys Steel Works, Ltd., are also busier. High-class small strips and bars are in good demand for engineering purposes, motor car manufacturing, and electricity undertakings, whilst there is a consistent demand for the class of strip required for the safety razor blade industry.

Welcome Orders.

It is announced that the Finland State Railways have placed an order for the greater part of their 1933 requirements of rails and sole plates with the United Steel Companies, Ltd., and Dorman, Long and Co., Ltd. The total tonnage involved is slightly in excess of 10,000 tons, with a total value of approximately £85,000 sterling. Cravens Railway Carriage and Wagon Company, Ltd., has received an important order for a fleet of express road coaches which are to be luxuriously constructed and fitted on the latest Leyland six-cylinder, long-wheel base type of chassis.

Tools Tariff.

The National Union of Manufacturers is promoting an application to the Tariffs Advisory Committee for an increased tariff upon imported carpenters', joiners', and building trade tools. The Committee will be asked to raise the duty of 20 per cent. to 33⅓ per cent. The demand for Sheffield tools continues strong in certain departments, but quiet in others, and exports are still increasing steadily. This applies particularly to saws, files and rasps.

Cutlery and Plate.

There is much activity in scissors and safety razor blades, but work on seasonal orders has fallen off. With the reduced spending power of a large section of the public, the demand for expensive cutlery and plate has been very poor in connection with the Christmas trade.

Public Schemes.

To prevent a recurrence of the disastrous flooding around Doncaster and Thorne, which occurred last year, large schemes are proposed, and it is expected that the cost of the work will exceed £200,000, provision for which is made in the Doncaster Area Drainage Bill. A scheme prepared by the Hemsworth Rural District Council for supplying the villages of Upton and North Elmsall with water from Pontefract at an estimated cost of £40,000, has been submitted to the Ministry of Health. The Scarborough Corporation has decided to purchase the Seamer Moor, 2 miles outside the town, for £8660, and it is proposed to construct a reservoir on a portion of the land. The Ministry of Transport is contributing 75 per cent. towards the cost of the reconstruction of Roper's Bridge at Whaplode, near Spalding and Boston, on the main road to the Eastern Counties. The Holland County Council has accepted a tender for £3018 for the work. It is proposed by the Skegness Council to carry out foreshore development schemes which include the extension of the serpentine waterway from the north beach, and the construction of a sea wall, with beach café, bathing chalets, &c. The estimated cost of the project is £19,000. The Lincoln City Council proposes to spend £15,000 on street improvements; £2000 on improvement of the city parks, and £14,000 on the extension of electric cables in Lincoln.

NORTH OF ENGLAND.

(From our own Correspondent.)

Warship Order for the Tyne.

Two of the four new war vessels ordered from British firms by the Portuguese Government will be built on the Tyne. An order for two sloops, each of 2110 tons, has been provisionally placed with Hawthorn, Leslie and Co., at Hebburn. News of the order is especially welcome in the Tyne district, as, with the launching of a Portuguese sloop from the Hebburn shipyard of Hawthorn, Leslie and Co., last week, the river is without a ship on any of its building stocks. The Walker Naval Yard, of Vickers-Armstrongs, Ltd., has been closed down for some time, and it is regarded as improbable that it will be reopened to execute the firm's new order from the Portuguese Government for two submarines. Inquiries tend to show that these vessels will be built at Barrow-in-Furness, where many similar craft have been constructed for different nations in the past. The two sloops to be built by Hawthorn, Leslie and Co. are expected to provide work for many men over a period of two years. The firm is already completing two sloops for the Portuguese Government, the second of which was launched last week.

Iron Trade Expansion.

Some interesting facts emerge from an examination of the return of iron and steel shipments from the Tees for the month of November. A decline of 323 tons in the total clearances is more apparent than real, since there was one working day less in November, but the fact is that in the pig iron trade there has been a very marked expansion, due almost entirely to the increased purchases by Scottish consumers. The specially low prices quoted by Cleveland makers for Scottish business and the stoppage of overseas sources of supply through the operation of the tariff have resulted in an increase in the deliveries to Scottish ports from 3007 tons in October to 6498 tons in November. The latter is the largest tonnage shipped to Scotland in any month this year, and indicates a welcome recovery of a valued market. The total shipments of pig iron coastwise and foreign for the month reached 10,145 tons, which is the highest tonnage since June, the principal foreign destinations being Italy 857 tons, Holland 772 tons, and Germany 469 tons. There was a slight decline in the manufactured iron and steel shipments, which totalled 24,837 tons, as against 27,033 tons in the previous month. Coastwise shipments were up by 366 tons, but foreign shipments fell from 17,139 tons to 14,577 tons, which is chiefly due to a temporary decline in trade with India and the Far East, and the total stoppage of shipments to South America, where the financial stringency is acute. After an interval of two months business with Russia has again revived, and 6474 tons delivered to Soviet ports places Russia at the head of the list. South and East African deliveries amounted to 4176 tons, whilst India took 1462 tons, China 709 tons, and Spain 702 tons.

Marked Drop in Imports.

The marked effect of tariffs is reflected in a big decrease in the imports of iron and steel during the past two months. Statistics presented at this week's meeting of the Tees Conservancy Commission showed that only 7901 tons of iron and steel were imported from foreign sources in October and November, as compared with 34,668 tons in the corresponding two months of last year, and 14,855 tons in 1913. The imports during the past two months comprised 6687 tons of crude sheet bars, billets, blooms, slabs, &c., 778 tons of rails, sheets, joists, plates, angles, &c., and 436 tons of pig iron.

Cleveland Iron Trade.

The Cleveland pig iron market presents a firm tone, and the outlook is distinctly brighter. There is a good volume of inquiry, and it is noticeable that in some instances buyers are prepared to discuss purchases over a period. Sellers report that they could make contracts for delivery next year at present prices, but hesitate to do so because of signs of advance in values. Home requirements are steady, and are sufficient to absorb the output. Prices to the home trade are unchanged, No. 1 Cleveland foundry iron being 61s., No. 3 G.M.B. 58s. 6d., No. 4 foundry 57s. 6d., and No. 4 forge 57s. Special prices are quoted for Scottish or foreign business.

Hematite Pig Iron.

There has been a gradual increase of late in the consumption of East Coast hematite pig iron, but stocks are still heavy, and makers are content to realise 59s. for mixed numbers and 59s. 6d. for No. 1 quality.

Iron-making Materials.

Business in foreign ore is virtually confined to sales of odd cargoes. Prices are based on Bilbao Rubio of 50 per cent. quality at 15s., c.i.f. Tees, but with freights likely to advance further, merchants hesitate to make sales.

Manufactured Iron and Steel.

In the heavy steel trade plant is not yet working to capacity, but there has been a gradual improvement of late, and naval orders should help to create some demand for shipbuilding material. Producers report a better overseas demand, and the rise in Continental prices has helped to stabilise the position. Scrap prices tend to advance further. Consumers are rather keen to buy for stock, and merchants are having to pay higher figures in order to fulfil commitments. Heavy steel is quite 37s. 6d., and 40s. is asked. Machinery metal finds a ready market, and good qualities realise 40s. There is a scarcity of this class of material, and some consumers are taking whatever qualities they can secure at present prices, which are very low, compared with values of foundry pig iron.

The Coal Trade.

The Northern coal trade is experiencing much improved conditions. The brisk demand for steam coal, especially good for home trade requirements though also active from Scandinavian centres, is hardening values. Several large orders from Scandinavian consumers have been placed for shipment over the next three or four months, and merchants are confident of business holding up to the end of the first quarter of next year. For the remainder of this year there is scarcely any large steam coal to be obtained. Both Northumberland and Durham collieries are full of orders, and quotations are at a higher level. For delivery after the turn of the year, supplies are limited, and best Northumberlands are firm at 14s. 6d. Tyne primes are also booked to the quota line, and collieries are seeking to buy the surplus of other pits. The price has a stronger range of 13s. 6d. to 14s. Steam smalls also meet a good demand, and output is readily cleared. Tyne best are at 9s., and secondary brands 8s. Wear prime smalls are steady at 11s. In Durham County large steams are maintaining the better price of 16s., and are well taken up to the end of the year. Gas coals are well booked, but still offer in goodly volume at 14s. 6d., with seconds at 13s. to 13s. 6d. Special Wear gas are also quoted steady at 15s. to 15s. 1¼d. Coking unscreened remain quiet at 12s. 6d. to 13s. The strength of the bunker trade is well maintained, the demand for the coaling stations and to the West Indies continuing active, and prices remain firm and supplies moderate. Best brands are fully 14s. and seconds 13s. to 13s. 3d. There has been a steady improvement in the demand for coke, and the undertone is firm. Production is now being readily taken

up. Gas coke is still scarce, quoting nominally at 18s. 6d. Patent oven coke is moving freely for good brands at 15s. 6d., and superior qualities at 16s. 6d. More coke nuts have been sold to the United States. Recent business concluded for delivery this month and next amounts to between 10,000 and 12,000 tons. The price of coke nuts is firm at 17s. to 18s.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding.

THE possibilities of an improvement in the shipbuilding industry remain very obscure, but the position at present is somewhat better than might have been expected. This slight improvement is due to the placing of naval work in September with the prospect of further orders on Admiralty account in the spring, and to a few general orders placed during the past two months. During the month of November, three vessels of 10,515 tons aggregate were launched from Clyde yards, bringing the total for this year to date to twenty-three vessels of 54,160 tons aggregate. Three orders were reported in November as follows:—Harland and Wolff are to build at Govan a passenger and cargo steamer for the Bombay Steam Navigation Company, Bombay; Messrs. Denny, Dumbarton, a first-class turbine steamer for the Clyde services of Williamson-Buchanan Steamers, and the Caledon Shipbuilding and Engineering Company, Dundee, a passenger and cargo motor ship for Alfred Holt and Co., Liverpool.

Scottish Shale Industry.

Recent improvement in the market for certain shale oil products has enabled the industry to earn a profit for the first time for several years. The directors of the shale oil companies are of the opinion that the increase in wages now possible should be coupled with an effort to bring back to employment, temporarily at least, some of the men formerly employed in the industry. The scheme proposed provides that all employees, so far as practicable, should work three consecutive weeks, with every fourth week an idle period, thereby providing employment for approximately 1000 men. Wages will be advanced as from November 30th last, by 10 per cent. bringing the rate back to the basis ruling prior to July 4th, 1928, and, in addition, a further advance of 2½ per cent. on these rates. An additional 30 per cent. will thus be made to the pay-roll, and with three weeks' pay at the advanced rate and one of unemployment relief, the average monthly income will equal the present rate of wages in the industry.

Steel.

The works engaged in the production of heavy steel are still comparatively quiet. General specifications are scarce, especially those for shipbuilding materials. Heavy sheets are not particularly well placed, but inquiries for the lighter gauges are quite substantial. Galvanised sheets are moderately active.

Tubes.

Though it has been stated that the proposal of Stewarts and Lloyds to erect plant in England for the production of Bessemer steel and tubes does not mean a removal south of this industry, it is expected that there will be a large reduction of the output in the West of Scotland. Expert opinion states that so long as the Clyde remains an important shipbuilding and shipping centre, the manufacture of tubes must be an important feature of local industry.

Iron.

Progress in bar iron and re-rolled steel bars is slow, and the plants still operate on the basis of about 40 per cent. of capacity. Bar iron prices are unchanged, while re-rolled steel bars are quoted £7 5s. home, and £6 10s. per ton export. The demand for pig iron is still mostly supplied from stocks in makers' yards. Last week 300 tons of pig iron arrived here from Barrow. Scrap material is comparatively quiet, with heavy steel about 35s., and cast iron machinery 47s. 6d. per ton.

Coal.

The market for export fuel continues very firm. The increase in the production quota has not affected the position, and the scarcity of supplies for shipment abroad is still acute. Lanarkshire splints are now very strong, and Lothians and Fifeshire steams are fully booked for the remainder of this year. With the exception of Lothians double nuts, smalls are likewise scarce and firm. Aggregate shipments amounted to 215,507 tons, against 235,929 tons in the preceding week, and 236,033 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

So far as business generally is concerned, while there is some ground for saying that operations are becoming somewhat more widespread, it cannot be said that the volume increases very perceptibly. The report from the G.W.R. Company of the shipments last week at the six ports in this area under its control is not at all encouraging, as the total only came to 344,200 tons, as compared with 396,430 tons, for the preceding week. There is this satisfaction, however, that the total for last week was 5610 tons better than the total for the corresponding period of last year. The fact that there was a reduction last week as compared with the previous week cannot be said to have been at all surprising, as the loading position during the second half was very unsatisfactory. The returns of idle tipping appliances showed that on Saturday last the total was forty-three, and these were distributed among all the ports between Newport and Swansea. As the result, however, of arrivals over the week-end, the situation was better on Monday, as the total of idle tips was reduced to twenty-nine, all of which were at the ports between Newport and Barry, where steam coals are shipped. At Port Talbot and Swansea the loading position was better, as no tips were idle at these ports and one steamer was waiting to berth at Port Talbot and two at Swansea. Not only is current business in coals without much development, but contract operations appear to be hanging fire. No news is yet to hand of the French State Railways having placed any of their requirements for 1933 with local concerns, though some information regarding this contract may come to hand at the end of this week. The Swedish State Railways are inquiring for prices for about 27,000 tons of coals for delivery from January to March next, though this business is more likely to go for North country coals. A report from St. John's, Newfoundland, that a contract has been made for the exchange of 40,000 tons of Welsh coal for 38,000 cords of Newfoundland pitprops finds no confirmation on this side, though it is known that certain negotiations have been in progress on these lines. In the case of patent fuel it is understood that part of the Algerian State Railways' contract for supplies over next year is to be placed with British Briquettes, Ltd. The actual quantity is not officially disclosed, though the fact that some of this business is to be given to Welsh patent fuel is interesting. Dutch producers secured the bulk of this order last year, and are believed to have obtained most of the business on this occasion. The railways' inquiry was for 127,000 tons for delivery over twelve months.

Coal Trade Finances.

A statement issued by the secretary of the South Wales Coalowners' Association upon the report of the joint accountants dealing with the proceeds, costs, &c., of the South Wales coal trade for the three months ended October 31st last, states that the report shows a debit balance of 3·76d. per ton, equal to £122,972, compared with a debit balance of £76,482, equal to 2·17d. per ton, in the previous three months, and with a debit balance of £57,481, or 1·52d. per ton, in the corresponding period of last year. The percentage certified as payable on the 1915 standard rates was minus 2·40, but under the agreement the colliery owners have guaranteed the payment of a minimum of 20 per cent. above the standard rates, and, accordingly, they are called upon to finance the whole of the margin between the minimum and the percentage certified by the auditors. The debit balance of £122,972 for the quarter ended October 31st last is exclusive of the capital and other charges which are not included in the joint audit. The output in the three months ended October 31st was nearly 7 per cent. less then in the previous months, and roughly 13 per cent. less than in the corresponding period of last year. For the twelve months ended October last, the output was 36,882,750 tons, as compared with 39,054,498 tons for the corresponding period of last year. The one bright spot has been the increase during the past twelve months of 112,405 tons in the quantity of coals supplied as bunkers to vessels engaged in the foreign trade, while statistics of the quantity of coal retained for home consumption in South Wales and Monmouthshire during the twelve months ended October last were 16,915,728 tons, as compared with 17,306,175 tons for the corresponding period of 1931.

Coal Delegation to Denmark.

Members of the delegation to Denmark returned home at the end of last week and among them were Mr. Evan Williams (chairman of the Coalowners' Association) and Sir John Beynon, who explained that they did not go to Denmark for the express purpose of searching for coal orders, but, in the same way as the steel delegation now in Oslo, for the purpose of doing spade work and clearing the ground in anticipation of the official negotiations to take place this week in London between representatives of the Danish Government and the British Government. The difficulty had been that when the Danish importers wanted a certain class of coal they applied to collieries which were fully booked with orders, and the Danes then declared that they could not get supplies of British coal. The delegation pointed out that there were many collieries in this country that could supply the kind of coal that was wanted, and if Denmark took South Wales coal in 1924 there was no reason why she should not take it now. The feeling prevailed that without doubt coal orders for this country would come along.

Docks Traffic.

Figures relating to the trade at the six ports in this area under the control of the G.W.R. Company for the four weeks ended November 20th last were encouraging, as the total of imports and exports was better than for several months past. The quantity came to 2,152,572 tons, which compared with 2,162,746 tons for the corresponding period of last year. Taking the whole of this year to November 20th last, the aggregate of imports and exports was 23,285,168 tons, as compared with 24,847,560 tons.

Steel and Tin-plates.

Following on the news of the securing of an order for one million boxes of tin-plates referred to last week, comes the report of efforts by Welsh manufacturers to obtain tin-plate business in Canada to the value of £1,000,000. In this connection it is stated that already sample orders have been placed by Canadian buyers with South Wales firms, and one of these running to 2000 tons has been placed with the Old Castle Tin-plate Company, Llanelly, the managing director of which is Mr. W. R. Brown, who returned three weeks ago from a business visit across the Atlantic. He is convinced that the Ottawa agreement has given Welsh makers an excellent opportunity to win back the Canadian market, provided the quality of their goods and the service are up to the standard which has been provided by American makers in the last few years. The healthier state of the tin-plate industry is indicated by the fact that the Llanelly Sheet Mills resumed operations on Monday after being shut down for a number of weeks. Employment will be given to 250 men. A resumption of work at the Old Lodge Tin-plate Works was also to take place this week. South Wales is also encouraged by the announcement that preparations are well advanced for the restarting of the by-product, coke-oven and blast-furnace departments of the Blaenavon Company, Ltd. There are three blast-furnaces and seventy-two coke ovens at Blaenavon which have not operated since the general strike in 1926. The fact that the Great Western Railway Company has placed an order for 100,000 steel sleepers, which represents 10,500 tons of steel, in addition to which a further 46,500 tons of steel rails, fish-plates, bolts and girders for bridges and structural work will be required, means more work for South Wales, as it is understood that the portion of the order placed locally will be shared between the Dowlais Works, Cardiff and Port Talbot.

Current Business.

The tone of the steam coal market has not undergone any material alteration. Chartering of tonnage has not been particularly active of late, though the prospects are slightly better, so that some collieries at any rate should benefit to some extent. The trouble is that the demand from abroad for large coal is so restricted, and this fact accentuates the shortage of the supplies of sized products for which there is a very steady inquiry. Prices have not changed to any extent, especially so far as large coals are concerned, while values for sized qualities remain firm. Patent fuel and coke are unaltered, while pitwood maintains recent prices of 22s. 6d. to 23s.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

UNITED WATER SOFTENERS, Ltd., has now removed to Permutit House, Gunnersbury-avenue, which has been specially built to suit its requirements. A show-room and sales department will still be maintained at Aldwych House, W.C.2.

THE COWPEN DRY DOCKS AND SHIPBUILDING COMPANY, Ltd., Blythe, Northumberland, informs us that its name has been changed to Blythe Dry Docks and Shipbuilding Company, Ltd. The constitution of the company will remain unchanged.

A CATALOGUE of British industry and trade in the Russian language is now being prepared by the *British Russian Gazette and Trade Outlook*. The scheme has the approval of the Soviet authorities, and 5000 catalogues will be distributed among the factories, industrial organisations and buying institutions of the U.S.S.R.

CONTRACTS.

MERRYWEATHER AND SONS, Ltd., have just received from the London County Council a repeat order for three super-type motor fire engines for London.

RANSOMES AND RAPIER, Ltd., Ipswich, have received from the L.M.S. Railway an order for five locomotive turntables of the "Mundt" type. Two turntables of 60ft. diameter and one of 55ft. diameter will be installed at Kentish Town Depôt and two others, of 55ft. and 50ft. diameter respectively, at Cricklewood Depôt.

JOHN I. THORNYCROFT AND CO., Ltd., have received an order from a titled owner for a 70ft. auxiliary motor yacht. The boat will be of 52 tons Thames measurement, with a length between perpendiculars of 59ft., a breadth of 15ft. 4½in., and a draught of 9ft. She will be equipped with a Thornycroft 30 B.H.P. petrol engine with reducing gear.

CRAVEN BROTHERS (MANCHESTER), Ltd., have recently secured a large order for axle plant for the Russian Government. The plant is to be installed in a new works which is being built and equipped to deal ultimately with 270,000 axles per annum. The machines being supplied by Craven Brothers are:—Semi-automatic electrically driven parting-off, centering, and journal shouldering machines; semi-automatic heavy type, high-speed improved double axle roughing lathes; semi-automatic high-speed improved double-axle finishing lathes; semi-automatic electrically driven axle journal burnishing lathes. The order was secured in the face of serious competition from Continental, particularly German, machine tool manufacturers.

INSTITUTION OF MECHANICAL ENGINEERS—ANNUAL DINNER: NORTH-WESTERN BRANCH.—The annual dinner of the North-Western Branch of the Institution of Mechanical Engineers took place on the evening of Thursday last, December 1st, at the Engineers' Club, Manchester, when a large number of members and guests attended. Professor Dempster Smith, the chairman of the branch, presided, and gave the loyal toast "The King, The Duke of Lancaster." "The Institution of Mechanical Engineers" was ably proposed by Sir Francis Joseph, who referred to the world depression and contrasted conditions in this country with more unfavourable trade conditions in America and Germany. He expressed himself optimistically as to the future, and said that in Manchester inquiries were now coming in in greater volume than before, and that with co-ordination and co-operation we should, he thought, win through. In his reply the President of the Institution, Mr. William Taylor, referred to the great success of the North-Western Branch and the many illustrious names of Manchester men who had built up the engineering industry of that district. The vigour of the branch denoted that the younger men were following the good example which had been set them. Mr. Taylor said that he was personally interested in the revival of the watch industry in this country, and expressed the hope that one outcome of the Ottawa agreement would mean a re-birth of the Lancashire watch industry. The toast of "Our Guests" was pleasingly proposed by Mr. D. L. Thornton, and in the regretted absence through an accident of the Lord Mayor of Manchester, Alderman William Walker, a member of the Institution and the Engineers' Club, Alderman Titt suitably replied. He was supported by Mr. C. A. Needham, the President of the Liverpool Engineering Society. The health of the Chairman, Professor Dempster Smith, was proposed by General Mowat, the Secretary of the Institution, who referred to Professor Dempster Smith's work for the Institution, particularly that in connection with the North-Western Branch and the Section C of the Examination, the Economics of Engineering. Mr. H. L. Guy supported General Mowat, and Professor Dempster Smith proposed the toast of "The Secretary," Mr. B. J. Tams, who briefly replied. The dinner was most successful in every way, and excellent arrangements were made which contributed to an enjoyable evening.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	15/6 to 20/-
(1) Spanish	17/- to 24/-
N.E. COAST—	
Native	18/- to 21/-
Foreign (c.i.f.)	15/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 7 6	—
No. 1 Foundry	3 10 0	—
No. 3 Foundry	3 7 6	—
N.E. COAST—		
Hematite Mixed Nos.	2 19 0	2 19 0
No. 1	2 19 6	2 19 6
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
MIDLANDS—		
(c) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold-blast)	—	—
North Staffs. Forge	3 1 0	—
„ „ Foundry	3 6 0	—
(c) Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
(c) Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	3 15 6 (*a*) 4 0 6 (*b*) 4 5 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	9 15 0	9 5 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 5 0	—
Common Bars	9 5 0	—
Best Bars	10 5 0	—
Double Best Bars	10 15 0	—
Treble Best Bars	11 5 0	—
LANCS.—		
Crown Bars	9 15 0	—
Best Bars	10 5 0	—
Hoops	12 0 0	—
S. YORKS.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	9 0 0 to 9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 0 0 to 8 10 0	—
Gas Tube Strip	10 7 6 to 10 10 0	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export £ s. d.
(5) SCOTLAND—		
Boiler Plates (Marine)	9 0 0	8 10 0
„ „ (Land)	—	—
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	7 15 0	7 15 0
Sheets (Gal. Cor. 24 B.G.)	11 5 0—10 Ton Lots and Upwards Delivered Glasgow Stations.	10 0 0
„ (Gal. Cor. 24 B.G.)	For Canada	10 15 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	7 2 6	—
Soft Billets	5 10 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
MANCHESTER—		
Bars (Round)	9 7 6	—
„ (Small Round)	7 0 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	8 10 0	—
SHEFFIELD—		
Siemens Acid Billets	9 2 6 (basis)	—
Hard Basic	8 2 6 and 8 12 6	—
Intermediate Basic	6 12 6 and 7 2 6	—
Soft Basic	5 15 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	7 10 0	—
MIDLANDS—		
Small Rolled Bars (all British)	7 0 0 to 7 5 0	—
Small Re-rolled Bars	6 15 0	—
Billets and Sheet Bars	4 17 6 to 5 7 6	—
Galv. Sheets	11 5 0 to 13 5 0	10 0 0
(2) Staffordshire Hoops	9 10 0	—
(*d*) Angles	8 7 6	—
(*d*) Joists	8 15 0	—
(*d*) Tees	9 7 6	—
(*d*) Bridge and Tank Plates	8 17 6	—
Boiler Plates	8 7 6 to 8 10 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14 f.o.b.	15/9 to 16/3
Block Tin (cash)	151 17 6
„ (three months)	152 10 0
Copper (cash)	30 15 0
„ (three months)	31 1 3
Spanish Lead (cash)	11 6 3
„ „ (three months)	11 15 0
Spelter (cash)	15 2 6
„ (three months)	15 8 9
MANCHESTER—	
Copper, Best Selected Ingots	36 10 0
„ Electrolytic	37 5 0
„ Strong Sheets	65 0 0
„ Tubes (Basis Price), lb.	0 0 10
Brass Tubes (Basis Price), lb.	0 0 9
„ Condenser, lb.	0 0 11½
Lead, English	13 7 6
„ Foreign	11 15 0
Spelter	15 10 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/10½ per lb.	
Ferro Tungsten	1/7½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£25 15 0	8/-
„ „ 6 p.c. to 8 p.c.	£24 10 0	7/6
„ „ 8 p.c. to 10 p.c.	£22 5 0	7/-
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£36 10 0	11/-
„ „ „ 1 p.c. carbon	£42 12 0	14/-
„ „ „ 0·70 p.c. carbon	£44 0 0	16/-
„ „ „ carbon free	1/- per lb.	
Metallic Chromium	2/9 per lb.	
Ferro Manganese (per ton)	£10 15 0 for home	
„ „ „	£9 15 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£13 10 0 scale 5/- per unit	
„ „ 75 p.c.	£19 10 0 scale 6/- per unit	
„ Vanadium	12/6 per lb.	
„ Molybdenum	6/3 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£245 0 0	
Ferro Cobalt	7/9 per lb.	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	14/-
„ „ Ell	15/6
„ „ Splint	15/6 to 17/-
„ „ Trebles	15/- to 16/-
„ „ Doubles	13/- to 13/6
„ „ Singles	11/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	14/- to 14/6
„ „ Jewel	16/6
„ „ Trebles	15/6 to 16/-
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	13/- to 14/-
Screened Navigation	16/6 to 17/6
Trebles	17/- to 18/6
Doubles	13/6 to 14/6
Singles	11/6 to 12/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	14/-
Secondary Steam	13/6
Trebles	15/6 to 16/-
Doubles	12/- to 12/6
Singles	11/3 to 11/6

(8) N.W. COAST— ENGLAND.

Steams	20/6 to 23/6
Household	32/6 to 52/6
Coke	19/- to 22/6
NORTHUMBERLAND—	
Best Steams	14/6
Second Steams	12/6 to 12/9
Steam Smalls	8/6
Unscreened	12/6 to 13/-
Household	27/- to 39/-
DURHAM—	
Best Gas	14/6
Second	13/3 to 13/6
Household	25/- to 37/-
Foundry Coke	24/-

SHEFFIELD—	Inland.	Export.
Best Hand-picked Branch	27/- to 28/-	—
South Yorkshire Best	23/- to 24/-	—
South Yorkshire Seconds	18/- to 21/-	—
Derbyshire Best House	22/- to 23/6	—
Derbyshire Best Brights	18/- to 20/-	—
Screened Seconds	17/6 to 19/-	—
Kitchen Coal	16/6 to 17/6	—
Best Screened Nuts	17/- to 18/6	—
Small Screened Nuts	16/- to 16/6	—
Yorkshire Hards	17/- to 18/-	—
Derbyshire Hards	17/- to 18/-	—
Rough Slacks	8/6 to 9/6	—
Nutty Slacks	7/- to 8/6	—

Blast-furnace Coke (Inland) 10/- on rail at ovens

Furnace and Foundry Coke (Export), f.o.b., 14/6 to 15/6

(9) SOUTH WALES.

CARDIFF—	
Steam Coals :	
Best Smokeless Large	19/6 to 19/9
Second Smokeless Large	18/9 to 19/6
Best Dry Large	19/- to 19/6
Ordinary Dry Large	17/9 to 18/3
Best Black Vein Large	18/3 to 18/6
Western Valley Large	17/9 to 18/-
Best Eastern Valley Large	17/7½ to 17/9
Ordinary Eastern Valley Large	17/3 to 17/6
Best Steam Smalls	13/- to 13/6
Ordinary Smalls	11/- to 13/-
Washed Nuts	19/- to 31/-
No. 3 Rhondda Large	19/6 to 19/9
„ „ Smalls	15/- to 16/-
No. 2 „ Large	17/- to 17/3
„ „ Through	15/6 to 16/-
„ „ Smalls	14/- to 14/3
Foundry Coke (Export)	22/6 to 36/6
Furnace Coke (Export)	17/- to 18/-
Patent Fuel	20/-
Pitwood (ex ship)	23/6 to 24/6
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	36/- to 38/6
Seconds	27/- to 34/-
Red Vein	22/- to 26/6
Machine-made Cobbles	37/6 to 48/6
Nuts	36/6 to 48/6
Beans	28/6 to 32/6
Peas	19/6 to 21/-
Breaker Duff	8/6 to 9/6
Rubbly Culm	8/6 to 9/6
Steam Coals :	
Large	20/- to 20/6
Seconds	18/- to 20/-
Smalls	11/6 to 13/-
Cargo Through	16/- to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate : Joists (minimum), 22/6 ; Ordinary Ship, Bridge, and Tank Plates and Sections, 15/- if home consumers confine purchases from associated British Steel Makers. (*e*) Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

The Steel Trade.

WHILE there is always a danger of steel prices giving way on the French market, despite the organisation of producers and merchants and the operation of the quota system, they have weakened again on the international market, merchant bars having lost their recent advance and being now quoted at £2 17s. 6d. gold, f.o.b. Antwerp. The susceptibility of the trade to slight influences has caused fluctuations which are generally more pronounced in a downward sense. The fall from the quotation of £3, which Belgian and Luxemburg producers were inclined to fix as a minimum, on the ground that it was absurd to continue selling at a loss, is attributed to the competition of French steel makers who keep up their own prices at home under cover of the quotas, and, notwithstanding their agreed restriction of output, have a surplus which they must dispose of abroad. All the slight tendencies of a favourable character are losing their effect, now that it is seen that no good can come from any change, except that produced by a general revival of confidence. Pending negotiations for the creation of a new basis for international exchanges, it is felt that no help can be looked for other than that provided by public works to be undertaken with the aid of the State. It is not improbable that these works will finally have to be carried out with money released from the huge national savings.

Trade Organisation.

The industrial situation has become so critical that attention is being centred this month on the Congresses to be held by the great national associations representing commercial and industrial interests. Their decisions will exercise a considerable influence upon the country's economic policy. The conflict between commercial and industrial interests becomes more pronounced as the discussion proceeds, and it is observable that the phenomenal decline of foreign trade has given far more importance to the commercial aspect of the problem. There is no longer any question of the country becoming self-supporting. That theory has been exploded by the experience of the past few years, and the difficulty now lies in conciliating the claims of the commercial community and of those industries which have been developed under cover of Protection to satisfy home demands. The Association Nationale d'Expansion Economique has given figures showing the decline of the foreign trade of different countries by a comparison between the first half of this year, and that of 1929, which was the year preceding the slump. Most countries suffered a decline of more than 50 per cent. in both imports and exports. The French decrease was 47 per cent. imports and 59 per cent. exports. Great Britain suffered less than any other country, her exports falling by only 48 per cent., while the United States topped the list with a decline of nearly 66 per cent. imports and 67 per cent. exports. The importance of taking immediate action to improve foreign exchanges is, therefore, paramount, for which reason opinion is strongly in favour of a more liberal system of exchanges based upon strict reciprocity. An obstacle is placed in the way of the realisation of this idea by some branches of the engineering and other industries which are powerfully organised for the defence of their interests. They demand more effective protection, which would lessen the possibilities of exchange. The struggle is so keen that it may protract a solution of the difficulty.

Scrapping Ships.

On the occasion of an important meeting of the International Chamber of Commerce in Paris last week to discuss a policy that would favour a return to normal trading conditions, a number of shipowners from ten countries assembled to decide upon what should be done, on their part, to help the economic rehabilitation by adjusting the supply of freights to the demand. Great Britain was represented at the meeting by Sir John Sandeman Allen, Sir Alan G. Anderson, K.B.E., of the Orient Line; Sir Percy E. Bates, of the Cunard Company; Lord Essendon; and Mr. R. S. Dalgliesh, Chairman of the Chamber of Shipping of the United Kingdom. The meeting was presided over by Herr Cuno, of the Hamburg-America Line. The discussion turned upon the necessity of all maritime countries following the lead given them by Great Britain and Germany in scrapping old ships, the tonnage to be thus sacrificed being determined by the special conditions obtaining in each country. No such general agreement could obviously be come to so long as some Governments continued their policy of artificially stimulating shipbuilding and of providing subsidies for running old ships that ought to be withdrawn from service. That practice, it was declared, must be abandoned. A sub-committee was therefore appointed under the chairmanship of Herr Cuno to see what measures should be taken to obtain a suppression of such State subventions and subsidies, after which it will be possible to arrange a general plan for the scrapping of obsolete tonnage.

Rail Motors.

One of the grievances of the railway companies is the stipulation in their concessions from the State that they shall maintain a service of trains on local lines whether there is any traffic or not. That obligation has been maintained in deference to political interests, but the companies recently secured some relief from the burden imposed upon them by permission to replace the trains with rail motors and even road vehicles. During the past two or three years trials have been carried out with rail motors, particularly on the P.L.M. and Midi systems, and the Midi Company has now asked the Government for authority to run rail motors on a group of local lines around Mont-de-Marsan, having a total length of 160 miles. These vehicles are propelled by solid-injection engines of the Junkers type, constructed by the Société Lilloise de Moteurs. It may be noted that the local lines are not included in the electrification of the Midi system.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

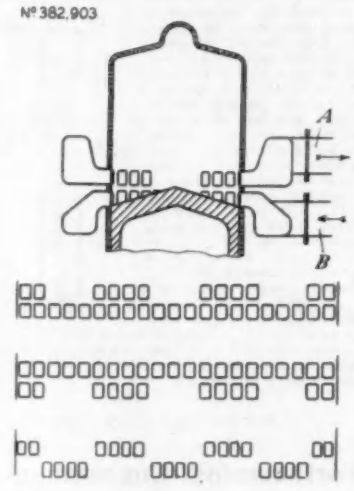
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

382,903. May 27th, 1932.—TWO-STROKE ENGINES, H. F. P. Purday, Harland and Wolff, Ltd., Belfast, and F. E. Rebbeck.

This invention aims at the even distribution in the cylinder of the flow of the scavenging air and the exhaust gases. This

Nº 382,903



is effected by disposing the ports symmetrically round the cylinder. The exhaust is shown at A and the scavenging inlet at B. The exhaust ports are completely uncovered before the scavenging ports. Three alternative arrangements of ports are shown in development.—*November 3rd*, 1932.

DYNAMOS AND MOTORS.

382,602. August 3rd, 1932.—SINGLE-PHASE SYNCHRONOUS MOTORS, International General Electric Company, Inc., of 120, Broadway, New York, U.S.A.

The invention relates to synchronously running single-phase alternating-current machines of the type comprising a rotor having no winding and arranged outside an internal stator, the stator and rotor being provided with rows of notches, the division of these rows being the same for both stator and rotor, and selected in accordance with the desired speed of rotation and the frequency of the available alternating current. For the purpose of exciting such a machine, a winding is employed which, when two rows of notches are used for the stator, is mounted between

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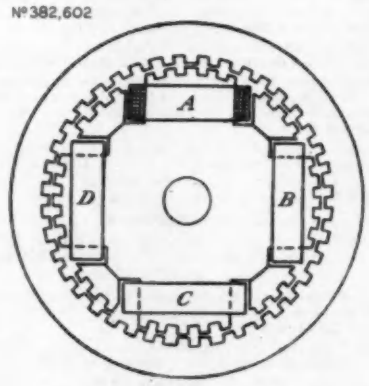

them. In order to overcome certain disadvantages, in accordance with the invention, at least four exciter coils are provided on the stator. The stator coils, which are mounted on corresponding pole cores, are indicated at A, B, C, and D. The coils may be so connected as to provide either two oppositely located pole zones or two adjacent ones, having the same polarity. The parts of the stator located between the excited zones are likewise notched, but take no direct part in the motor action. The stator is preferably supported in such a way that it can oscillate on its own axis within a given angle. By this means the motor when starting will fall into synchronism more easily and with greater certainty. Moreover, pulsations in the angular velocity of the rotor will be avoided.—*October 27th*, 1932.

382,303. July 22nd, 1931.—CASINGS OF DYNAMO-ELECTRIC MACHINES, *William Edward Evans, of 27, Chancery-lane, London, W.C.2.*

The bars A of the casing of an electric machine built in accordance with the invention are recessed at B, and the stator plates C are held in the recesses by the pressure plates D. Contrary to the usual arrangement, these pressure plates are not secured to the casing bars, but are clamped into the bars A together with the stator plates. The bars A extend over the coil heads E on both sides to such an extent that the rings F holding the bars together have the same axial dimensions with respect to the holes for the base as in the case of solid casing machines. The cover plates G are secured to the rings F. The retaining rings F have a larger external diameter in comparison with the overall distance between any two oppositely disposed bars, so that the air can flow not only inside the space formed by the bars and the backs of the stator plates, but can also circulate around the stator plates, the current of air moving either along the surface of the

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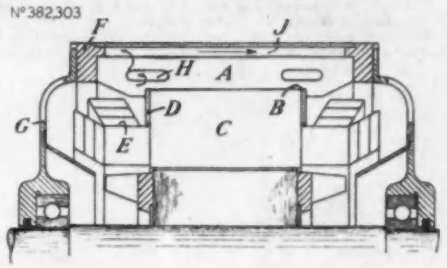

bars or through the holes H in them, as indicated by the arrows J.—*October 24th*, 1932.

SWITCHGEAR.

382,565. May 5th, 1932.—ELECTRIC CIRCUIT BREAKERS, *John James Victor Armstrong, of 12, Church-street, Liverpool.*

This specification describes a low-tension circuit breaker for use with direct or alternating-current circuits. The current enters the circuit breaker by a conductor A, and divides into two parallel circuits B and C, one including a coil D and the other a coil E and a graphite resistance F. The two circuits unite at G and are connected to an outgoing conductor. The coils D and E operate a differential-action releasing arrangement, which may consist of an armature located between the two coils. The coil E in series with the graphite resistance tends to cause opening of the circuit, and the coil D, acting in the opposite direction to the releasing coil E, tends to prevent this occurring. If the total current increases beyond the limit for which the apparatus is designed, the graphite resistance F becomes heated, and consequently its ohmic resistance diminishes. The intensity of the current therefore increases more rapidly in the circuit of the coil E than in that of the coil D. After a time, determined by the regulation of the apparatus, the temperature of the graphite resistance F and consequently its ohmic resistance, reaches such a value that the flux produced by the coil E causes the release of the apparatus.—*October 27th*, 1932.

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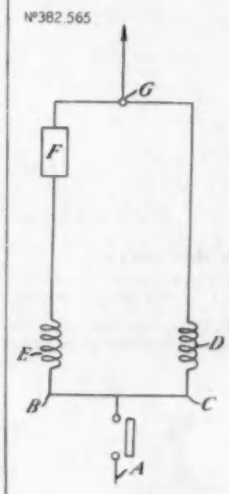

FURNACES.

382,898. May 19th, 1932.—ANNEALING METAL STRIP, O. Junker, Lammersdorf Kr., Monschau, Germany.

In order to increase the rate at which such materials as bright brass strip can be heated in an annealing furnace, they are dusted over with a powder of earth, graphite, charcoal or soot. The powder is much more absorbent of radiant heat than

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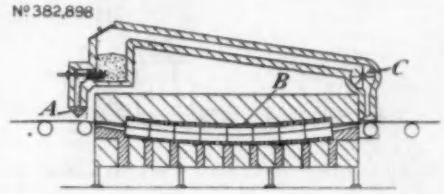

the bright strip and increases the rate of heating. The powder is applied at the entrance to the furnace by the shaking trough A. The strip then passes through the muffle B, and on emerging the dust is sucked off by the fan C and returned to the feed end. The dust may be moistened to make it adhere to the strip.—*November 3rd*, 1932.

MACHINE TOOLS AND SHOP APPLIANCES.

382,821. January 30th, 1931.—WIRE-DRAWING DIES, *The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.*

This invention relates to an improved method of and apparatus for drawing wire, rods, tubes, ornamental beading, and the like, ensuring improved lubrication between the drawing die and the material being drawn. The material is drawn first

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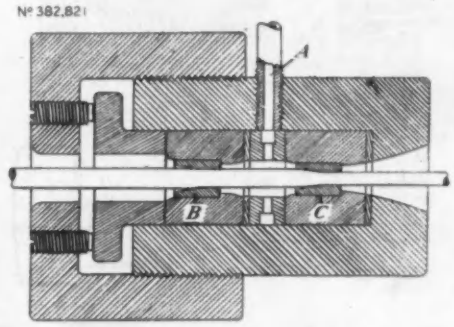
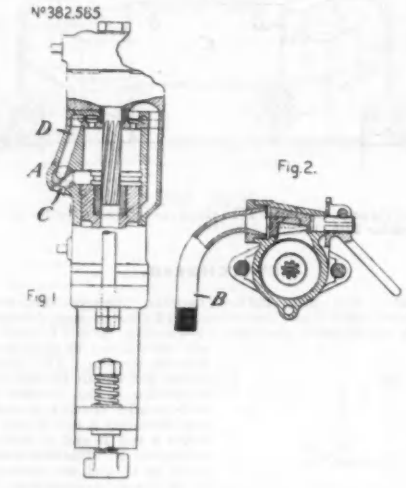


through a sealing die and then through a drawing die while forcing lubricant under heavy pressure into a closed space between and defined by the two dies. Sufficient pressure is employed to urge the lubricant between the die and the work despite the lubricant-expelling pressure developed there-

between, even when heavy draughts are taken. The inlet for the lubricant is shown at A and the two dies at B and C.—*November 3rd*, 1932.

382,585. May 6th, 1931.—PNEUMATIC TOOLS, Sir W. G. Armstrong, Whitworth and Co., Ltd., and E. H. Sweester, Scotswood Works, Newcastle-on-Tyne.

This is a form of double-ported valve for controlling the operation of a rock drill and for providing a blast of air down

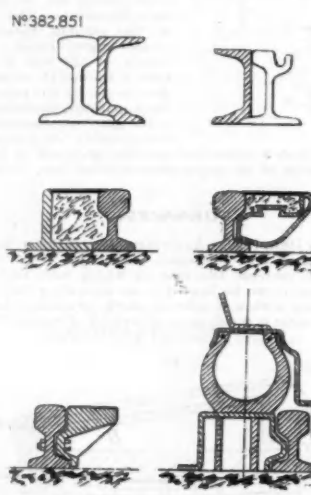


the drill steel to clear away chips. The valve is shown at A and receives air axially at B. As shown in Fig. 1, air goes to the working cylinder and the exhaust C is fully open. By turning the valve the admission port D is closed, as is also the exhaust, while air is directed down the drill steel.—*October 27th*, 1932.

TRAMWAYS AND RAILWAYS.

382,851. March 8th, 1932.—PERMANENT WAY FOR PNEUMATIC TIRES, Michelin et Cie., Clermont Ferrand, Puy-de-Dôme, France.

This rail is intended for use with pneumatic tires, and aims at the provision of a larger bearing surface without it being

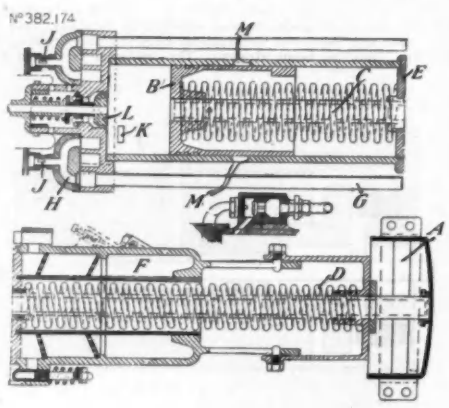


necessary to scrap existing rails. The extra surface can be provided in several different ways, as shown by the sketches, which need no description. No reference is made to the means adopted to pass the additional rail by the fish-plates of the existing rails.—*November 3rd*, 1932.

MISCELLANEOUS.

382,174. February 20th, 1932.—INTERNAL COMBUSTION RAMMING TOOLS, J. N. Johnson, Wharfdene, Skipton-road, Ilkley, Yorks.

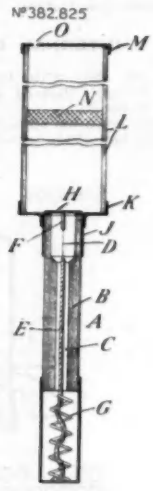
The drawing has been cut in the centre to save space, and the upper half represents the explosion chamber, while below there is the ramming end. The ram tool is shown at A, and is



connected with the piston H by the piston-rod. The two springs C and D abut against the division plate E. F is a petrol chamber, the vapour from which passes through the pipes G to the mixing chamber H. Air is admitted at J, J. The mixture passes to the cylinder by the port K. A scavenging valve is shown at L and exhaust ports M, M. The action is as follows:—The spring D is compressed and then released. It pushes the cylinder up over the piston, and is assisted in this action by the explosion of a charge. Meanwhile the spring C is compressed. When the exhaust ports M, M are uncovered the pressure falls, so that the scavenging valve L opens and the spring C shoots the piston up inside the cylinder, so that the whole machine is off the ground. It then, naturally, falls again, and on the rammer meeting the ground, the spring D is re-compressed and the cycle is repeated.—*October 20th*, 1932.

382,825. February 2nd, 1932.—HIGH-TENSION CUT-OUTS, *General Electric Company, Inc., of 120, Broadway, New York, U.S.A.*

The high-tension cut-out described in this specification is of the kind in which gas produced as the result of fusion of a fusible element within a cartridge is expelled under pressure into a chamber connected to the cartridge, and having communication with the atmosphere. The chamber is so dimensioned that its length and gas capacity are greater than the length and capacity of the cartridge, and the gas can be accommodated within the chamber at a moderately high pressure. A is the cartridge for the cut-out device, the cartridge consisting of an insulating body B having a comparatively long bore C, which is widened at its upper end and arranged to accommodate the cut-out fuse wire D, the ends of which are fused to the leads E and F respectively. The lead E is tensioned by the tensioning spring G, while the lead F is held by a small plate H, which rests on a metallic sleeve J, which embraces the end of the insulating body B, and carries a flange K, to which a longer hard paper tube is fixed. The length of the hard paper tube in relation to a normal size cartridge is more than 1 m., and is closed at the other end by a cover M, provided with an opening O. Inside the hard paper tube there is a metal layer N of about 30 mm. to 80 mm. in thickness, which consists of small metallic rings, such layer being adapted, if desired, to take the place of the cover M and form the closing wall of the tube.—*November 3rd*, 1932.



Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INST. OF ELECTRICAL ENGINEERS: N.E. CENTRE, STUDENTS.—Armstrong College, Newcastle-upon-Tyne. "Applications of Electricity on Ships," Mr. N. H. Denholm. 7.15 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Informal meeting. Discussion, "A Comparison between Communistic and Capitalistic Methods of Organisation," introduced by Mr. J. L. Hodgson. 7 p.m.

INST. OF METALS: SHEFFIELD LOCAL.—In Non-ferrous Section of Applied Science Dept. of University, Sheffield. "Degreasing and Cleaning (Vapour Cleaning)," Mr. W. F. Jesson. 7.30 p.m.

INST. OF SANITARY ENGINEERS.—Abercorn Rooms, Great Eastern Hotel, E.C.2. Annual dinner. 6.30 p.m.

JUNIOR INST. OF ENGINEERS.—At Royal Soc. of Arts, Adelphi, W.C.2. Presidential Address, "The Future of Water Power in Great Britain," Sir Alexander Gibb. 7.30 p.m.

KEIGHLEY ASSOCIATION OF ENGINEERS.—Queen's Hotel, Keighley. "Glass and Glass-making," Mr. R. F. Taylor. 7.30 p.m.

N.-EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS.—Mining Inst., Newcastle-upon-Tyne. "Manœuvring of Ships, Semi-balanced Rudders of Twin-screw Ships," Mr. G. H. Bottomley. 6 p.m.

RAILWAY CLUB.—57, Fetter-lane, E.C.4. "Some Pre-war Cross-country Train Services," Mr. G. W. T. Daniel. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse, by Mr. J. G. Gray. 9 p.m.

FRIDAY AND SATURDAY, DECEMBER 9TH AND 10TH.

BOROUGH POLYTECHNIC.—Borough-road, S.E.1. Exhibition of Students' Work. Friday, 6–9 p.m.; Saturday, 2.30–9.30 p.m.

SATURDAY, DECEMBER 10TH.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND STUDENTS.—Visit to works of Yorkshire Sugar Company, Ltd., Selby. Meet at works, 3.15 p.m.

N. OF ENGLAND INST. OF MINING AND MECHANICAL ENGINEERS.—Newcastle-upon-Tyne. Meeting at 2.30 p.m.

MONDAY, DECEMBER 12TH.

INST. OF MECHANICAL ENGINEERS: GRADUATES.—Storey's gate, S.W.1. "Injectors for Boiler Feeding Purposes," Mr. F. T. Barwell. 6.45 p.m.

INST. OF METALS: SCOTTISH LOCAL (Joint Meeting with Inst. of Engineers and Shipbuilders in Scotland).—39, Elmbank-crescent, Glasgow. "Ageing and Age-hardening in Metals," Dr. C. H. Desch, F.R.S. 7.30 p.m.

INST. OF TRANSPORT.—At Inst. of Electrical Engineers, Savoy-place, W.C.2. Discussion, "British Main Line Electrification," Mr. F. Lydall. 5.30 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2. Fothergill Trust Lecture, "Design and Construction of Buildings in Relation to Fire Risks," Mr. Maurice E. Webb. 8 p.m.

TUESDAY, DECEMBER 13TH.

BRITISH ENGINEERS' ASSOCIATION (INCORPORATED).—Hotel Victoria, Northumberland-avenue, London, W.C.2. Monthly luncheon meeting, 12.30 p.m.; lunch, 1 p.m. Speaker, Sir Thomas M. Ainscough, C.B.E., "Conditions and Prospects of British Engineering Trade in India." Meeting will terminate at 2.30 p.m.

DIESEL ENGINE USERS ASSOC.—Caxton Hall, S.W.1. "Report of Committee on Heavy-oil Engine Working Costs, 1931–32." 3 p.m.

HULL ASSOCIATION OF ENGINEERS.—At Hull Co-operative Society's Dairy, Great Thornton-street, Hull. "Modern Dairying," Mr. W. A. Stansfield. 7.15 p.m.

ILLUMINATING ENGINEERING SOCIETY.—Joint meeting with Society of Glass Technology.—Caxton Hall, S.W.1. "An Introductory Review of the Work of the B.S.I. Sub-Committee on Light Diffusing Glass," Dr. S. English; "The Theory and Specification of Opal Diffusing Glasses," Part I., Mr. J. W. Ryde and Mr. B. S. Cooper; Part II., Mr. B. S. Cooper and Mr. W. A. R. Stoyle; "Some Aspects of the Manufacture of Opal Glass," Dr. W. M. Hampton. 6.30 p.m.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. Discussion, "Causes and Prevention of Bed Erosion, with Special Reference to the Protection of Structures Controlling Rivers and Canals," Mr. A. D. Butcher and Mr. J. D. Atkinson. 6 p.m.

INST. OF ELECTRICAL ENGINEERS: N. MIDLAND STUDENTS.—Hotel Metropole, Leeds. "Damaging Characteristics of Lightning Surges," Mr. H. C. Bowker. 7.15 p.m.

INST. OF ELECTRICAL ENGINEERS: SCOTTISH.—North British Station Hotel, Edinburgh. "Relative Fuel Economy of Electricity, Gas, Oil, and Solid Fuel as Heating Agents," Mr. A. H. Barker. 7 p.m.

INST. OF ELECTRICAL ENGINEERS: S. MIDLAND STUDENTS.—University, Edmund-street, Birmingham. Students' lecture, "Switchgear," Dr. C. C. Garrard. 7 p.m.

INST. OF MARINE ENGINEERS.—The Minories, E.C.3. "Experiences with High-pressure Steam Installations in the Royal Navy," Engineer-Capt. S. R. Dight, R.N. 6 p.m.

INST. OF METALS: N.E. COAST LOCAL.—Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-upon-Tyne. "Centrifugal Casting of Non-ferrous Alloys," Mr. F. W. Rowe. 7.30 p.m.

INST. OF PETROLEUM TECHNOLOGISTS.—At Royal Society of Arts, John-street, Adelphi, W.C.2. "The New de Laval S.N. Process of De-waxing and Acid Refining of Mineral Oils," Mr. Nils Backlund. 5.30 p.m.

INST. OF STRUCTURAL ENGINEERS: YORKSHIRE.—Hotel Metropole, Leeds. "Reconstruction of Ryde Pier and Contingent Works," Mr. C. J. Jackaman. 7 p.m.

SHEFFIELD METALLURGICAL ASSOCIATION.—198, West-street, Sheffield. "Metallurgical Aspects of Electrical Manufacture," Mr. W. R. Franklin. 7.30 p.m.

WEDNESDAY, DECEMBER 14TH.

INST. OF CIVIL ENGINEERS: MANCHESTER AND DISTRICT ASSOCIATION.—Visit to works of Pilkington Brothers, Ltd., St. Helens. Leave Manchester Exchange Station 2 p.m.

INST. OF CIVIL ENGINEERS: STUDENTS' MEETING.—Great George-street, S.W.1. "The Diversion of the Grimsby Main Outfall Sewer and Graving Dock Discharges," Mr. J. A. Fisher. 6.30 p.m.

INST. OF ELECTRICAL ENGINEERS: N.E. CENTRE, STUDENTS' SECTION.—Visit to the Optical Works of Sir Howard Grubb, Parsons and Co., Ltd., Newcastle-upon-Tyne. 6 p.m.

INST. OF ENGINEERING INSPECTION.—At Royal Soc. of Arts, John-street, Adelphi, W.C.2. "Air Compressors: Representative Types and Modern Test Bed Practice," Mr. Sydney E. Goymour. 5.30 p.m.

INST. OF ENGINEERS-IN-CHARGE.—St. Bride Institute, Fleet-street, E.C.4. "Design and Operation of a Thermal Electric Storage Plant," Mr. E. M. Ackery. 7.30 p.m.

INST. OF MECHANICAL ENGINEERS: YORKSHIRE.—Grand Hotel, Sheffield. "Manufacture and Installation of a Modern Water-tube Boiler," Major S. J. Thompson, D.S.O. 7.30 p.m.

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY.—A Special General Meeting will be held in the Science Museum, South Kensington, to commemorate the bicentenary of Sir Richard Arkwright. At 4.45 in Gallery XXIV., a demonstration of the Arkwright machines will be given by Mr. G. Tilghman Richards. At 5.30 in the Lecture Theatre a Public Lecture on "Arkwright's Life and Work" will be given by Mr. Frank Nasmith, F.T.I., of Manchester. This will be followed by a cinematograph film. The lecture will be open to the public.

ROYAL METEOROLOGICAL SOC.—49, Cromwell-road, S. Kensington, S.W.7. Meeting at 5 p.m.

THURSDAY, DECEMBER 15TH.

INST. OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCN.—Queen's Hotel, Birmingham. Annual Dinner. 6.30 p.m. for 7 p.m.

INST. OF ELECTRICAL ENGINEERS.—Joint meeting with Inst. of Mechanical Engineers and Inst. of Fuel. Savoy-place, Victoria Embankment, W.C.2. "Post-war Development in High-pressure Boilers," Messrs. C. H. Davy and C. H. Sparks. 6 p.m.

INST. OF METALS: BIRMINGHAM LOCAL.—University, Birmingham. "Welding of Copper," Mr. H. Martin. 7 p.m.

INST. OF STRUCTURAL ENGINEERS.—10, Upper Belgrave-street, S.W.1. "The Lay-out of Roads in Towns," Col. C. H. Bressey. 6.30 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS.—Engineers' Club, Albert-square, Manchester. By invitation of the N. Western Branch of Inst. of Mechanical Engineers. "Mechanical Experiments and Inventions of Dr. Z. de Ferranti, F.R.S.," Mr. A. Hall. 7.15 p.m.

N. EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS: TEESSIDE BRANCH.—Cleveland Scientific and Technical Inst., Middlesbrough. "Rejuvenation and Reconditioning of Ships and their Machinery," Mr. Andrew Hamilton. 7.30 p.m.

SOC. OF CHEMICAL INDUSTRY: PLASTICS GROUP.—Visit to Avonmouth Works of Messrs. J. Robinson and Co. (Seed Crushers). 2.30 p.m. University, Woodland-road, Bristol. "Use of Rubber and Ebonite in the Chemical Industry," Mr. N. Swindin. 7.30 p.m. Hart's Restaurant, Broad-street, Bristol. Informal dinner. 6.30 p.m.

FRIDAY, DECEMBER 16TH.

INST. OF ELECTRICAL ENGINEERS: N. EASTERN.—Old Assembly Rooms, Westgate-road, Newcastle-upon-Tyne. Annual dinner. 7 for 7.30 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. "Piston Temperatures in a Solid-injection Oil Engine, and Experiments on a Supercharged Single-cylinder High-speed Petrol Engine," Dr. G. F. Mucklow. 6 p.m.

INST. OF MUNICIPAL AND COUNTY ENGINEERS.—84, Eccleston-square, Westminster, S.W.1. "Heavy Traffic—Light Traffic," Dr. P. E. Spielmann. 6.30 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Manufacture of Photographic Films," Dr. H. Baines. 7.30 p.m.

RAILWAY CLUB.—Broad-street Station Restaurant. Twenty-sixth annual dinner.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse by Sir George Macdonald. 9 p.m.

SATURDAY, DECEMBER 17TH.

INST. OF CIVIL ENGINEERS.—Students' visit to Kempton Park Works of the Metropolitan Water Board.

MANCHESTER ASSOC. OF ENGINEERS.—College of Technology, Sackville-street, Manchester. Conversazione and dance. 6.45 p.m.

TUESDAY, DECEMBER 20TH.

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C.2. "Engineering Research at the National Physical Laboratory," Dr. H. J. Gough. 7.30 p.m.

OLD CENTRALIANS.—Devereux Restaurant, Devereux-court, W.C.2. Luncheon. 1 p.m.

SHEFFIELD METALLURGICAL ASSOCIATION.—198, West-street, Sheffield. "Reduction of the Emission of Smoke from Mill Furnaces," Mr. T. Stock. 7.30 p.m.